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14. ABSTRACT

Purpose: This report outlines progress made during the second year of the "Risk Factors for Discharge from the Army with a Permanent Disability" research project.

Scope: The overall goal of this project is to describe disability, including temporal trends in disability rates and the profile of those who experience disability, and to uncover the underlying factors contributing to disability among US Army soldiers in order to inform the development of targeted and cost-efficient disability reduction strategies.

Major Findings to date: Musculoskeletal disability is increasing more rapidly than other types of disability, particularly among females, soldiers between the ages of 21-35, white soldiers, of lower to mid-level enlisted ranks with relatively short service tenure, and by soldiers without a college education. Lighter physically-demanding jobs have higher unadjusted rates of any-cause hospitalizations whereas heavier physically-demanding occupations have higher injury-specific hospitalization rates. Preliminary evidence suggests gender interactions such that men in physically demanding jobs are at increased risk for injury-related hospitalizations and for on-duty accidents resulting in hospitalizations,; women in heavy demand jobs are not at increased risk for injury but are at increased risk for "all-cause" hospitalizations. There are also demographic and occupational exposure differences in risk for being discharged with a mental health disability.

15. SUBJECT TERMS
Disability, VASRD, military occupation, hospitalization, TAIHOD, Army, epidemiology, injury

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INTRODUCTION

Disability is a large and growing problem among U.S. Army soldiers. In 1981 there were 178 soldiers discharged with permanent disability per every 100,000 on active duty. By 2005 the risk had climbed to 1,262 per 100,000 soldiers on active duty. Over 100,000 soldiers have left the army with a permanent disability between 1981 and 2005. The Army has decreased in size over this time period but the numbers of disabilities have actually increased despite army downsizing. In 2005, there were over 7,000 soldiers discharged from the Army with a permanent disability. Despite the magnitude of disability and increasing trend, relatively few studies have described occupational or demographic risk factors (3).

The overall goal of this project is to describe disability, including temporal trends in disability rates and the profile of those who experience disability, and in the process begin to uncover the underlying causes or factors contributing to disability among US Army soldiers. A major aim is to identify factors associated with an increased risk for medical disability discharges or retirement with a disability from the Army in order to develop targeted and cost-efficient disability reduction strategies. Disability is the end result of a combination of exposures and individual and environmental interactions with the exposure including baseline health status and health behaviors, occupational exposures and environment, and demographic and body composition factors. Some of these factors may be modifiable. If identified prior to the onset of a potentially disabling condition it may be possible to prevent or reduce the consequences of disability through targeted intervention strategies to reduce the burden of disability.

During the first year of our study we focused on establishing contracts, setting up analytic files, cleaning, the data and conducting exploratory and descriptive analyses. Early research accomplishments included analysis of the disability codes (VASRD codes) in order to clarify their clinical significance. This required identification of a subset of disability records with accompanying hospital administrative files. In order to fully understand the relationship between disability “diagnoses” (Veterans Administration Schedule for Rating Disabilities [VASRD]) and clinical diagnoses (according to the International Classification of Disease – (9^{th} Revision – Clinical Modification [ICD-9-CM]) we compared VASRD codes to ICD-9-CM codes.

We also initiated exploration of occupational codes in order to accurately classify occupational exposures. Assessment of occupational codes required the construction of a crosswalk to link jobs whose codes changed over time. We then moved to addressing one of our key research questions regarding the baseline incidence of disability and describing the general characteristics of disability. At the end of the first year of this study we had completed a draft of a paper documenting increasing disability rates. We were also able to determine that the increasing disability rates were not explained by temporal changes in the demographic composition of the army. At the end of year one we had also completed a draft of a report describing the linkage of VASRD codes to ICD-9-CM codes.

This remainder of this report describes progress made during the second year of the "**Risk Factors for Discharge from the Army with a Permanent Disability**" research project.

This research for this entire study draws upon data from the Total Army Injury Health Outcomes Database (TAIHOD) (1, 2). Established at the U.S. Army Research Institute of Environmental Medicine (USARIEM) in 1994 to specifically examine the impact of injury and disability outcomes among U.S. Army soldiers, the TAIHOD now contains electronic records for all soldiers who have been on active duty since 1971 (approximately 5 million individuals). These data sources, which are linked at the level of the individual soldier, contain information on disabilities, demographic and occupational characteristics including job type, discharge from the Army and reason for separation, inpatient and outpatient health care utilization, health habit information and other health outcomes and conditions such as deaths, and treatment for alcohol or drug-related problems.

STATEMENT OF WORK OBJECTIVES

Table 1 displays the annual statement of work objectives and products for all three years of this study. Some of the work completed this year pertains to the final results of work partially completed during the first year of the project. The final results of these efforts that were started in year 1 are described below.

TABLE 1. Statement of Work Objectives by Year, 2006-2009

Year 1 (2006-2007)	Year 2 (2007-2008)	Year 3 (2008-2009)
SOW1, Set up collaborator agreements	SOW 6, Paper 2	SOW 10, Paper 5
SOW 2, Update databases and clean/test	SOW 7, Paper 3	SOW 11, Paper 6
SOW 3, MOS crosswalk construction	SOW 8, Technical Report Recommendations for refining job demands scale & MOS crosswalk	SOW12, Paper 7
SOW 4, Technical report ICD-9-CM /VASRD crosswalk construction	SOW 9, Paper 4	SOW 13, Paper 8
SOW 5, Paper 1	Annual Report due July 2008	Final Report Due September 2009
Annual Report Due July 2007		

CONTINUED PROGRESS FROM YEAR 1 STATEMENTOF WORK

SOW 4, Technical Report 1

In the beginning of year 2 we completed analyses comparing the VASRD codes and ICD-9-CM linkage. Key findings from the linkage of the VASRD codes to ICD-9-CM codes were described in detail in our annual report last year. The original grant proposal did not promise a product. However, we felt that the findings would be useful to others working with disability. A copy of the published technical report describing findings from linkage of VASRD codes to ICD-9-CM clinical codes may be found in Appendix A.

SOW 5, PAPER 1

In the beginning of our second year on this project we made revisions to and finalized our first descriptive paper on disability. Key findings were reported in last year's annual report. The finished paper, entitled "The changing profile of disability in the U.S. Army" 1981-2005," was published in January of 2008 and also picked up by the press as a topic of keen interest (http://www.eparent.com/main_channels_military/The_Changing_Profile_of_Disability_in_the_U_S_Army_A_Study.asp). A copy of this published paper is attached in Appendix B.

YEAR 2 STATEMENT OF WORK PROGRESS

Table 2 details work promised for year 2 and the pages on which text relevant to each aim may be found. Following the table are details regarding each SOW for year 2.

Table 2. Statement of Work Objectives for Year 2

Year 2 SOW#	Task	Page Reference
6	Paper 2	4
7	Paper 3	5
8	Technical Report 2	16
9	Paper 4	17

SOW 6, PAPER 2

The second paper we completed this year describes the distribution of specific types of disability overall and by time as well as the disposition or variations in disability compensation awards overall and by disability type. The paper, "Temporal changes in

the nature of disability: U.S. Army soldiers discharged with disability, 1981-2005," is currently in press at *Disability and Health Journal*. The objectives of this paper were to (1) document and describe the relative proportion of disabilities by major type over the study period; (2) describe the population at risk for different types of disability; and (3) document and describe the type of compensation (an indicator of severity) awarded for different types of disability and any temporal changes in these associations. Analyses of 108,119 active-duty Army soldiers discharged with permanent disability between 1981 and 2005 revealed that over 90% of all disability is captured within the top five most prevalent types of disability: musculoskeletal (72%, N=77,418) neurological (6%, N=6,896), mental health (5%, N=5,075), cardiovascular system (4%, N=4,429) and respiratory (4%, N=4,202). We found that musculoskeletal disability rates are increasing rapidly (+2.5% per year); neurological and cardiovascular disability rates are decreasing (-1.3% and -10.0% annually, respectively), and respiratory and mental health disability rates did not change significantly. We also found demographic risk factors to vary by disability type. The greatest risk for musculoskeletal disability was experienced by female soldiers, soldiers who were between the ages of 21-35, white, of lower to mid-level enlisted ranks with relatively short service tenure, and by soldiers without a college education. Compensation awards associated with permanent disability from the Army also varied by disability type: Overall, 77% (N=83,320) received separation with severance pay, 15% (N=16,107) received a permanent disability retirement and 8% (N=8,692) received separation without benefits. Separation with severance pay was the largest and fastest growing disability disposition for all disabilities and for musculoskeletal disability specifically. A copy of the final version of this accepted paper is provided in Appendix C.

SOW 7, PAPER 3

The technical reports and first two papers we completed pertained primarily to specific aim 1 in the grant proposal and were designed to provide baseline descriptive information about disabilities as well as assessing the quality of the data. Paper 3 marks the beginning of the second phase of our study. Phase two focuses on characterizing the relationships between different risk factors and disability overall and by specific subcategories of disability. Phase 2 efforts fall primarily under specific aim 2 in the approved grant protocol.

Analyses for Paper 3, SOW 7, are proving quite challenging for the reasons described in our second technical report. The Army's approach to changing occupational codes, often with little documentation, has made it extremely difficult to track job exposures across time. Paper 3 applies the results of the Military occupational physical demand crosswalk (described in 2007 Annual report and under SOW 9 below). Due to limitations in the data and unexpected data anomalies found during the exploratory crosswalk analyses, the completion of the original technical report and the selection of a study population to begin paper 3 were delayed. However, we have still made significant progress on Paper 3.

We began by exploring the population of soldiers in the most common heavy-, moderate- and light-physical demands occupational groups during calendar year 2000. The methods are described in detail in the technical report (also see SOW 8). The heavy-demands MOS population comprises: Infantryman (11B), Fighting Vehicle Infantryman (11M), Automated Logistical Specialist (92A), Unit Supply Specialist (92Y), Motor Transport Operator (88M), M1 Armor Crewman (19K), Light-wheel Vehicle Mechanic (63B), Cannon Crewmember (13B), Combat Engineer (12B), Food Service Operations (92G), Petroleum Supply Specialist (77F), Cavalry Scout (19D), Chemical Operations Specialist (54B), Multichannel Transmission System Operator/Maintainer (31R), and Indirect Fire Infantrymen (11C). The most common moderate physically-demands jobs were: Medical Specialist (91B), Military Police (95B), Signal Support Systems Specialist (31U), Personnel Services Specialist (75H), Personnel Administration Assistant (75B), Multiple Rocket Launch System Crewmember (13M), PATRIOT Launching Station Enhanced Operator/Maintainer (14T), Signals Intelligence Analyst (98C), Telecommunications Operator-Maintainer (74C), Satellite Communications Systems Operator-Maintainer (31S), Medical laboratory Specialist (91K), AH-64 Attach Helicopter Repairer (67R), Radio and Communications Security Repairer (35E), Transportation Management Coordinator (88N), and Microwave Systems Operator-Maintainer (31P). The light physical-demands group comprises: Administrative Specialist (71L), Intelligence Analyst (96B), Finance Specialist (73C), Aviation Operations Specialist (93P), Legal Specialist (71D), Counterintelligence Agent (97B), Medical Supply Specialist (76J), BRADLEY Linebacker Crewmember (14R), PATRIOT Fire Control Enhanced Operator Maintainer (14E), Operating Room Specialist (91D), Electronic Warfare/ Intercept Systems Repairer (33W), Imagery Analyst (96D), Patient Administration Specialist (71G), Human Intelligence Collector (97E), and Preventive Medicine Specialist (91S).

The goal of this study is to follow soldiers working in jobs with varying levels of physical demands in order to ascertain differences in risk for injury and disability. A "crosswalk," described in our second technical report (SOW 9), links these 45 codes with occupational physical demand ratings and tracks these occupational groups over time. However, occupational demand levels have not been coded for all MOS jobs. Thus, we are unable to follow soldiers who leave one of the top 45 jobs that have been coded. As our intent is to measure the association between occupational exposure to job demands and risk of injury and disability, it is essential that we are able to fully characterize the soldier's exposure to occupational demands. Thus, only those who remained in the same known occupational physical demand category over a follow up period (i.e., those that we could accurately identify as either "heavy," "moderate" or "light" throughout our study period from 2000 to 2005) were retained in the analytic study population. Eighty-five percent (N =261,096) of the originally identified top 45 MOS remained in their demands group for the study period or were discharged during the follow-up (2000-2005)

We were concerned that this analytic decision might result in bias if soldiers who were in heavy-physical demands jobs got injured and then transferred to lighter demands work. To test this hypothesis, we compared health outcomes for soldiers who

remained in the same physical demand category (“consistent”) to those who either changed out of their physical demand level or switched to an occupation that had not been coded for physical demands (“changed”). The results did not support the hypothesis and in fact those who changed appeared to be at lower risk for some health outcomes than those who remained in their original job demands groups for the entire study period (Table 3). We found no difference in hospitalization patterns for those who changed versus those who had consistent occupational demand exposures; We found that soldiers who changed were actually less likely to experience disability (5.2% of consistent versus 2.4% of changed). Therefore we can reject the hypothesis that individuals may be changing out of certain physical demand levels because they are injured. See Table 3 for details.

Table 3. Total Population Identified as Top 45 in 2000, Consistent versus Changed through 2005

	Consistent N=261,096 85.41%		Changed N=47,085 15.40%		Total N=305,708	
Outcomes	N Row % Column%	Days to Event Mean ± SD Min/Max	N Row % Column%	Days to Event Mean ± SD Min/Max	N %	Days to Event Mean ± SD Min/Max
Hospitalizations						
Any Hospitalization	43,960 83.80% 17.00%	730.33±542.49 0 / 2,039	8,444 16.20% 17.93%	898.72±582.47 0 / 2,037	52,134 17.05%	757.61±552.65 0 / 2,039
Musculoskeletal (Any Position)	7,252 81.17% 2.78%	853.78±590.28 0 / 2,038	1,682 18.83% 3.57%	1023.78±591.68 0 / 2,038	8,934 2.92%	885.78±586.19 0 / 2,038
Injury (Any position)	9,091 84.03% 3.48%	808.61±571.47 0 / 2,039	1,728 15.97% 3.67%	976.95±594.63 1 / 2,037	10,819 3.54%	835.50±578.50 0 / 2,039
Injury Accidental, On Duty	3,480 83.55% 1.33%	917.82±562.47 0 / 2,039	685 16.45% 1.45%	1062.31±562.09 5 / 2,038	4,165 1.36%	941.59±564.88 0 / 2,039
Disability						
Disability (Any)	13,462 92.35% 5.16%	890.34±579.89 0 / 2,038	1,115 7.65% 2.37%	1,170.46±565.60 4 / 2,038	14,577 4.77%	911.76±583.56 0 / 2,038
Musculoskeletal Disability (Any Position)	9,945 92.11% 3.81%	842.46±576.28 0 / 2,038	852 7.89% 1.81%	1,139.29±573.07 4 / 2,038	10,797 3.53%	865.88±581.54 0 / 2,038

There were some demographic differences between those who remained in their job demands categories and those who changed to a different job demands group or changed to an unassigned job demands occupation. Table 4 illustrates the demographic differences between the 2 groups. Soldiers who remained within the same category of known physical demand were more likely to be female, younger, single, less well-educated (having no greater than a high school degree), of lower rank, and of fewer tenure years.

Table 4. Total Population Identified as Top 45 in 2000, Consistent versus Changed through 2005

Demographics	Consistent N=261,096 85.41% N Row% Column%	Changed N=44,612 14.59% N Row% Column%	Total N=305,708 N Column%
Gender (4 missing/unknown)			
Male	213,760 84.83% 81.87%	38,224 15.17% 85.68%	251,984 82.43%
Female	47,332 88.11% 18.13%	6,388 11.89% 14.32%	53,270 17.57%
Age (36 missing/unknown)			
<21	50,320 90.93% 19.27%	5,017 9.07% 11.25%	55,337 18.10%
21-25	96,169 88.88% 36.83%	12,037 11.12% 26.98%	108,206 35.40%
26-30	52,673 82.26% 20.17%	11,363 17.74% 25.47%	64,036 20.95%
31-35	30,397 76.55% 11.64%	9,314 23.45% 20.88%	39,711 12.99%
36-40	21,983 80.57% 8.42%	5,303 19.43% 11.89%	27,286 8.93%
>40	9,524 85.83% 3.65%	1,572 14.17% 3.52%	11,096 3.63%
Race/Ethnicity (270 missing/unknown)			
White	140,141 85.40%	23,949 14.60%	164,090

Demographics	Consistent N=261,096 85.41% N Row% Column%	Changed N=44,612 14.59% N Row% Column%	Total N=305,708 N Column%
	53.67%	53.68%	53.68%
African-American	79,214 85.28% 30.34%	13,668 14.72% 30.64%	92,882 30.38%
Hispanic	24,538 86.28% 9.40%	3,902 13.72% 8.75%	28,440 9.30%
Indian/Alaskan	2,222 87.34% 0.85%	322 12.66% 0.72%	2,544 0.83%
Asian/ Pacific Islander	7,845 85.61% 3.00%	1,319 14.39% 2.96%	9,164 3.00%
Other	6,897 82.92% 2.64%	1,421 17.08% 3.19%	8,318 2.72%
Marital Status *(216 missing/unknown)*			
Single	134,533 89.47% 51.53%	15,828 10.53% 35.48%	150,361 49.18%
Married	116,154 81.36% 44.49%	26,619 18.64% 59.67%	142,773 46.70%
Widowed/Divorced/ Legally Separated	10,213 82.64% 3.91%	2,145 17.36% 4.81%	12,358 4.04%
Education (4,035 missing/unknown)			
< High School	3,320 90.56% 1.27%	346 9.44% 1.26%	3,666 1.20%
High School Grad/ GED/ Alt. Ed.	236,874 85.95% 90.72%	38,723 14.05% 86.80%	275,597 90.15%
Some College	10,960 77.53% 4.20%	3,177 22.47% 7.12%	14,137 4.62%
≥College degree	6,469 78.19% 2.48%	1,804 21.81% 4.04%	8,273 2.71%

Demographics	Consistent N=261,096 85.41% N Row% Column%	Changed N=44,612 14.59% N Row% Column%	Total N=305,708 N Column%
Rank (3 missing/unknown)			
E1-E4	168,510 90.09% 64.54%	18,541 9.91% 41.56%	187,051 61.19%
E5-E6	71,592 79.58% 27.42%	18,369 20.42% 41.18%	89,961 29.43%
E7-E9	20,991 73.16% 8.04%	7,702 26.84% 17.26%	28,693 9.39%
Time in Service			
<= 1 year	63,714 90.20% 24.40%	6,924 9.80% 15.52%	70,368 23.11%
1+ to 2 years	32,165 89.75% 12.32%	3,673 10.25% 8.23%	35,838 11.72%
2+ to 3 years	31,256 89.45% 11.97%	3,685 10.55% 8.26%	34,941 11.43%
3+ to 4 year	24,538 87.98% 9.40%	3,352 12.02% 7.51%	27,890 9.12%
4+ to 5 years	14,872 85.18% 5.70%	2,588 14.82% 5.80%	17,460 5.71%
5+ to 7 years	22,401 84.12% 8.58%	4,230 15.88% 9.48%	26,631 8.71%
7+ to 10 years	22,821 79.41% 8.74%	5,919 20.59% 13.27%	28,740 9.40%
10+ to 15 years	22,972 73.79% 8.80%	8,161 26.21% 18.29%	31,133 10.18%
15+ years	26,357 81.26% 10.09%	6,080 18.74% 13.63%	32,437 10.61%

Despite some demographic differences, the lack of evidence of a healthy worker type bias made us comfortable selecting only soldiers who remained in their same physical demand group for analysis. Thus, we limited the cohort to only those soldiers who remained in the same known level of physical demand from 2000 to 2005 or who left during the study follow-up period but remained in their demands group prior to discharge from the Army (N=261,096). Table 5 shows the demographic characteristics for the entire study population overall and stratified by level of occupational physical demand. Men comprise the highest percentage of the heavy demands group while women make up a larger percentage of the light group. Soldiers under 30 make up greater proportions of heavy followed by moderate and light demands whereas soldiers over 30 make up larger proportions of the light groups compared to moderate and heavy occupational demands groups. There were no marked differences in race/ethnicity across demand groups. Single soldiers were slightly more represented among heavy occupational demands than moderate and light while no-longer-married solders were slightly more present in the light group. Soldiers with no greater than a high school degree make up a larger proportion of the heavy group followed by the moderate and then light where soldiers with higher levels of education make up larger proportions of light and then moderate physical demand groups (14.57% of light soldiers have at least some college or greater versus 9.54& for moderate versus 4.16% for heavy). Lower-ranked soldiers (E1-E4) comprised a greater proportion of heavy physical demands whereas higher-ranking soldiers (E7-E9) made up the greatest percentage of light physical demands compared to their proportion of moderate and heavy groups). Increasing time in service was more common within the light physical demands whereas fewer years in service was more common among the heavy demands group.

Age, rank and time and service are highly correlated age (Rho=0.82749, p<.0001) and with rank (Rho=.81606, p<.0001). Age and rank were also correlated, though not as strongly, with Rho=0.74463, p<.0001. The Cronbach Coefficient Alpha for these three variables was 0.762449 and the standardized alpha was 0.921322. This will inform further analyses for this paper as we develop multivariate models.

Table 5. Demographics of Primary Study Population by Physical Demand Level

Demographics	Heavy N=164,497 63.08%	Moderate N=69,015 26.43%	Light N=27,384 10.49%	Consistent N=261,096 85.41%
Gender *(4 missing/unknown)*				
Male	143,633 87.21%	52,683 76.34%	17,444 63.70%	213,760 81.87%
Female	21,062 12.79%	16,330 23.66%	9,940 36.30%	47,332 18.13%
Age (30 missing/unknown)				
<21	32,928 19.99%	12,289 17.81%	5,103 18.63%	50,320 19.27%

Demographics	Heavy N=164,497 63.08%	Moderate N=69,015 26.43%	Light N=27,384 10.49%	Consistent N=261,096 85.41%
21-25	63,427 38.51%	24,144 34.98%	8,598 31.40%	96,169 36.83%
26-30	31,657 19.22%	15,121 21.91%	5,895 21.53%	52,673 20.17%
31-35	18,407 11.18%	8,508 12.33%	3,482 12.72%	30,397 11.64%
36-40	13,238 8.04%	6,044 8.76%	2,701 9.86%	21,983 8.42%
>40	5,023 3.05%	2,899 4.20%	1,602 5.85%	9,524 3.65%
Race/Ethnicity *(239 missing/unknown)*				
White	87,796 53.31%	38,475 55.75%	13,870 50.65%	140,141 53.67%
African-American	50,121 30.43%	19,845 28.75%	9,248 33.77%	79,214 30.34%
Hispanic	15,832 9.61%	6,295 9.12%	2,411 8.80%	24,538 9.40%
Indian/Alaskan	1,436 0.87%	576 0.83%	210 0.77%	2,222 0.85%
Asian/ Pacific Islander	5,001 3.04%	1,992 2.89%	852 3.11%	7,845 3.00%
Other	4,344 2.64%	1,779 2.58%	774 2.83%	6,897 2.64%
Marital Status *(196 missing/unknown)*				
Single	88,438 53.70%	32,759 47.47%	13,336 48.70%	134,533 51.53%
Married	70,794 42.98%	32,992 47.80%	12,368 45.17%	116,154 44.49%
Widowed/Divorced/ Legally Separated	5,336 3.24%	3,218 4.66%	1,659 6.06%	10,213 3.91%
Education *(3,473 missing/unknown)*				
< High School	2,385 1.45%	695 1.01%	240 0.88%	3,320 1.27%
High School Grad/ GED/ Alt. Ed.	153,621 93.27%	60,699 87.95%	22,554 82.36%	236,874 90.72%
Some College	4,761 2.89%	4,051 5.87%	2,148 7.84%	10,960 4.20%
≥College degree	2,096 1.27%	2,531 3.67%	1,842 6.73%	6,469 2.48%
Rank				

Demographics	Heavy N=164,497 63.08%	Moderate N=69,015 26.43%	Light N=27,384 10.49%	Consistent N=261,096 85.41%
(3 missing/unknown)				
E1-E4	109,009 66.19%	42,437 61.49%	17,064 62.31%	168,510 64.54%
E5-E6	44,414 26.97%	19,874 28.80%	7,304 26.67%	71,592 27.42%
E7-E9	11,272 6.84%	6,703 9.71%	3,016 11.01%	20,991 8.04%
Time in Service				
<= 1 year	40,397 24.53%	16,342 23.68%	6,975 25.47%	63,714 24.40%
1+ to 2 years	23,061 14.00%	6,309 9.14%	2,795 10.21%	32,165 12.32%
2+ to 3 years	21,745 13.20%	6,838 9.91%	2,673 9.76%	31,256 11.97%
3+ to 4 year	14,017 8.51%	7,996 11.59%	2,525 9.22%	24,538 9.40%
4+ to 5 years	8,944 5.43%	4,507 6.53%	1,421 5.19%	14,872 5.70%
5+ to 7 years	13,588 8.25%	6,627 9.60%	2,186 7.98%	22,401 8.58%
7+ to 10 years	13,481 8.19%	6,662 9.65%	2,678 9.78%	22,821 8.74%
10+ to 15 years	13,981 8.49%	6,291 9.12%	2,700 9.86%	22,972 8.80%
15+ years	15,483 9.40%	7,443 10.78%	3,431 12.53%	26,357 10.09%

Table 6 shows the distribution of outcomes by physical demand for our study population (N=261,096) as well as time to each event. For most outcomes, there was little variation in time from the start of the follow-up period to each outcome of interest by physical demand groups. Time to any hospitalization event was shorter for soldiers in light demands jobs suggesting that this population is at greatest risk for an adverse outcome. However, these are unadjusted for gender and other demographic factors. All these associations will be tested in multivariate models as the analysis for paper 3 moves forward.

Table 6. Outcomes of Total Study Population by Physical Demand Level

	Heavy N=164,697 63.08%		Moderate N=69,015 26.43%		Light N=27,384 10.49%		Total Consistent N= N=261,096	
Demographics	N Row % Column%	Days to Event Mean ± SD Min/Max	N Row % Column%	Days to Event Mean ± SD Min/Max	N Row % Column%	Days to Event Mean ± SD Min/Max	N Row % Column%	Days to Event Mean ± SD Min/Max
Hospitalizations								
Any Hospitalization	25,711 58.85% 15.61%	739.04±548.54 0 / 2,039	12,548 28.72% 18.18%	726.68±541.32 0 / 2,037	5,431 12.43% 19.83%	697.54±514.45 0 / 2,036	43,960 17.00%	730.33±542.49 0 / 2,039
Musculoskeletal (Any position)	4,413 60.85% 2.68%	860.67±586.69 0 / 2,038	2,084 28.74% 3.02%	853.37±576.44 0 / 2,037	755 10.41% 2.76%	814.66±551.65 0 / 2,024	7,252 2.78%	853.78±590.28 0 / 2,038
Injury (Any position)	6,284 69.12% 3.82%	809.44±571.94 0 / 2,039	2,125 23.37% 3.08%	813.08±575.86 0 / 2,037	682 7.50% 2.49%	787.09±553.47 0 / 2,022	9,091 3.48%	808.61±571.47 0 / 2,039
Injury Accidental, On Duty	2,527 72.61% 1.53%	920.08±566.94 0 / 2,039	728 20.92% 1.05%	923.07±557.21 4 / 2,031	225 6.47% 0.82%	875.41±528.55 0 / 2,007	3,480 1.33%	917.82±562.47 0 / 2,039
Disability								
Disability (Any)	8,341 61.96% 5.06%	890.64±584.34 0 / 2,038	3,602 26.76% 5.22%	897.31±568.00 0 / 2,037	1,519 11.28% 5.55%	872.15±583.26 0 / 2,031	13,462 5.16%	890.34±579.89 0 / 2,038
Musculoskeletal Disability (Any Position)	6,128 61.62% 3.72%	840.30±580.51 0 / 2,038	2,669 26.84% 3.87%	856.90±563.20 0 / 2,037	1,148 11.54% 4.19%	820.39±583.30 0 / 2,031	9,945 3.81%	842.46±576.28 0 / 2,038

We hypothesized that there may be gender interactions with job demands. It is possible that the type of demands women face will differ for men. Differences in body composition may also result in a different pattern of risk for women than men. We conducted exploratory analyses to assess interactions between gender and physical demand in terms of injury and disability outcomes. Preliminary stratified Chi-Square models suggest several significant interactions exist. There is a significant and positive association between heavy job demands (versus other job demand categories combined) and risk for "any cause" hospitalization among women (OR =1.11 (95% CI = 1.07-1.16)). But, there is not a significant association for men (OR = 0.99 (95% CI = 0.96-1.01)). In contrast, women in heavy demands jobs do not appear to be at greater risk for injury hospitalizations (OR = 1.00 (95% CI = 0.89-1.13)), but men in heavy demands jobs are at significantly greater risk for injury hospitalizations (OR =1.29 (95% CI =1.23-1.36)). Similarly, men in heavy (versus light or moderate) job demands are at significantly increased risk for on-duty accident injury hospitalizations (OR = 1.56 (95% CI = 1.43-1.69)). But, women are not (OR = 0.98 (95% CI = 0.80-1.21)).

There did not appear to be evidence of an interaction for musculoskeletal hospitalizations or disability outcomes. Men and women in heavy job demands are at lower risk of musculoskeletal hospitalizations but the OR did not achieve statistical significance for women, possibly due to smaller sample sizes (OR = 0.90 (95% CI = 0.85-0.95) and OR = 0.90 (95% CI = 0.80-1.00), respectively). Odds of a disability for men in heavy (versus light and moderate) demands jobs = 1.03 (95% CI = 0.99-1.07) and for women: OR = 0.98 (95% CI = 0.91-1.05) in heavy (versus light or moderate) demands jobs were not at significantly greater risk for musculoskeletal disabilities. OR = 1.03 (95% CI = 0.98-1.08) and neither were women: OR = 0.95 (95% CI = 0.87-1.03).

Because women in heavy demands jobs are at increased risk of hospitalization overall, but not injury or musculoskeletal hospitalizations, it begs the question of what types of conditions women in heavy demands jobs are being hospitalized for. This will be explored in more detail in later planned analyses.

SOW 8, Technical Report

Technical Report 2 details the methods and results from the tracking and tracing of selected MOS occupational codes over time (SOW3) as well as findings when we linked the job demands to health outcomes and related recommendations for refining the job demands scale (SOW8). Some of this work was described in last year's annual report where we described the proposed process we were using to link military occupations with physical demand levels, complications and challenges related to extensive coding changes over time and ultimately how a cohort of heavy, moderate and light physically-demanding jobs held by enlisted Army soldiers were identified. During this year we acquired more personnel data and were thus able to expand upon the originally identified subpopulation to extend the cohort up through 2006. This additional data also revealed more coding changes which took time to sort out. The final result of the analyses captures the top (in terms of population size) occupations, representing each of the three different levels of physically-demanding occupations.

The study population comprises the top 15 most common "heavy" demands jobs, the top 15 most common "moderate" demands jobs, and the top 15 most common "light" physically-demanding jobs among all enlisted military occupations from 1980 to 2006 (referenced above in SOW7). To assess whether job demands classifications were relevant from a health outcomes point of view, we calculated unadjusted injury rates for soldiers within each level of physical demand, and across individual occupations. Overall, we found that lighter physically-demanding jobs have higher rates of any-cause hospitalizations whereas heavier physically-demanding occupations have higher rates of injury-specific hospitalizations. We also found that on-duty serious accidents (those resulting in an injury hospitalization) occur more frequently among heavy physically-demanding jobs. Soldiers in 11B (Infantrymen), 19D (Cavalry Scout) and 11C (Indirect Fire Infantrymen) were at greatest risk for on-the-job injuries resulting in hospitalization within heavy physically-demanding occupations.

Our results provided interesting findings about the Army's current job demands scale. Injury hospitalization rates as well as data on whether injuries are job-related suggest that military occupations are generally accurately classified as light, moderate and heavy physical demands. However, the higher incidence of injury among soldiers assigned to heavy physically-demanding jobs might suggest that the assignment and reclassification processes are in need of revisions or more thorough implementation. Alternatively, it could suggest that the demanding nature of these jobs still results in greater injury risk even among those soldiers who are most physically fit. Our results and interpretations of the job demand scale are currently published in an U.S. Army Research Institute of Environmental Medicine Technical Report. This report, "Physical Demands of Army Military Occupational Specialties: Constructing and Applying a Crosswalk to Evaluate the Relationship between Occupational Physical Demands and Hospitalizations" documents the process by which we crosswalked MOS codes by physical demand and then crosswalked MOS codes over time, along with the rates of hospitalizations experiences by each demand cohort. A copy of the published report is provided in Appendix D.

SOW 9, Paper 4

We have completed analyses for paper 4 and are working on a rough draft. We have invited Dr. Charles Hoge, a noted Army mental health epidemiologist/psychiatrist, to participate on this study. He will provide input on interpretation of key findings.

The goal of paper 4 is to describe demographic and other risk factors associated with mental health disability in order to inform the development of targeted interventions that will ultimately help reduce the burden of mental health-related disability. In particular, the paper aims to identify prior health utilization patterns associated with mental health (MH) disability; to clarify variations in risk associated with different types of mental health disability including different MH disability subcategories within the broader disability category of "mental health disorders," and to assess the role of combat in predicting MH disability.

We hypothesize that individuals ultimately discharged from the army with a mental health related disability will have a different history of medical care utilization (different with regard to frequency of visits and/or diagnoses) than either those discharged from the army with another type of disability or those discharged with no disability. We further hypothesize that different types of mental health disorders, as indicated by different VASRD mental health subcategories, will be associated with different prior patterns of healthcare utilization, demographics and occupational risk factors. Finally, we hypothesize that mental health disabilities associated with combat will differ from those that are not combat related both in terms of the primary type of mental health disability (type of VASRD mental health disability subgroup) and with regard to prior healthcare utilization patterns. This information may be useful in identifying individuals particularly vulnerable to developing mental health disorders during combat and thus help with targeted interventions.

We are utilizing a case-control design with two different sets of controls. Cases are soldiers discharged between January 1981 and December 2005 with a permanent disability and a primary VASRD code of mental health disability (7,002). Controls were selected in a 2:1 ratio to cases. Control group A are soldiers discharged from the Army during the study period with a permanent disability other than mental health (N = 14,004). Control group B are soldiers discharged from the army during the study period but who had neither a disability evaluation record nor a permanent disability record (N = 14,004).

Multinomial logistic regression analyses were used to assess associations between demographic and hazard pay characteristics among cases and the two control samples. Separate and independent multinomial models, adjusted for all background characteristics, were conducted for each prior hospitalization variable. Logistic regression models compared permanent disability for mental health disorders associated with combat compared to no combat and hostile versus no hostile fire. Logistic regression models compared diagnostic categories related to mental health disorders. Soldiers who did not have hazardous duty pay were treated as “missing” but retained in the model for analysis purposes. The most common mental health disability categories were mood disorders (29%), psychotic disorders (24%), anxiety disorders (13%) and cognitive disorders (9%). The remaining 25% were distributed over several categories. Just under 10% of mental health disability appear to be combat related (9.5%).

Because of differences in health utilization patterns and occupational exposures between enlisted soldiers and officers, findings from multivariate models are reported separately. Enlisted soldiers discharged with a permanent mental health disability were more likely than those discharged with another type of disability to be male, older, “other” minority status (not white, black or Hispanic), single or previously married. They were also more likely to have served recently in the infantry, communications, health care, task specialist, support, and supply career fields and they were more likely to have received hazardous duty pay for hostile fire. They were less likely to have received

hazardous duty pay for parachuting or for foreign duty assignments. Compared to soldiers discharged without a permanent disability, soldiers with mental health disability were more likely to be older, single, in infantry, communications, health care, tech specialist, and support jobs. They were less likely to be in equipment repair or "non-occupational" groups and they were less likely to have received special pay for parachute duty or foreign assignment (these were protective factors). Hostile fire pay was not significantly associated with the outcome for this comparison.

Only 11% of soldiers with mental health disability had no prior hospitalizations, compared with 34% of soldiers with other types of disabilities and 69% of soldiers with no recorded disability upon leaving the service. Risks are particularly high for mental health related hospitalizations but also for substance abuse, and for injury.

Officers discharged with mental health disability were more likely than officers discharged with other types of disability to have had a prior hospitalization for mental health or substance abuse in the past year. They were less likely to have had 2 or more years of service time. When compared to officers discharged without permanent disability, officers discharged with a permanent mental health disability were more likely to be older, single or previously married, have some college education or greater, and more likely to be female in lower ranks and shorter time on active duty. They were more likely to have had a prior hospitalization for mental health, substance abuse, and injury. They were less likely than officers discharged without disability to have received hostile fire pay. This suggests the risk factors and patterns of mental health disability vary considerably between officers and enlisted.

ADDITIONAL GRANT RELATED ACTIVITIES COMPLETED IN YEAR 2

SOW 10, Paper 5

We have also made progress towards Paper 5 which is a promised deliverable in Year 3 of this grant. We have begun exploratory analyses both to refine the outcome measure (musculoskeletal disability types) and to identify and validate potential risk factors such as height and weight (and BMI) data. Exploratory efforts of available TAIHOD data reveal that the Defense Enrollment Eligibility Reporting System (DEERS - https://www.dmdc.osd.mil/appj/deerswebsite/about.do?pageID=2) files contain height and weight measures for active-duty soldiers. There are records for approximately 3 million active-duty soldiers in the DEERS from January 2000 through June 2006 and nearly 100% of DEERS records contain height and weight values to calculate BMI. Table 7 illustrates file availability and proportion of the Army represented by these files.

Table 7. Distribution of available DEERS records, 2000-2006

Year	DEERS		Total Army	% Total Army with DEERS
	Individuals	%Height and Weight		
2000	333,197	99.63%	551,413	60.43%
2001	354,885	99.70%	551,141	63.39%
2002	390,733	99.78%	554,322	70.49%
2003	432,896	99.82%	559,002	77.44%
2004	481,394	99.84%	568,825	84.63%
2005	536,663	99.86%	564,802	95.02%

Investigation of demographic characteristics of soldiers with height and weight data suggests that the distribution of soldiers within the DEERS files are generally representative of the Army at large. Demographics of soldiers with personnel files at the time of their first DEERS record are reported below in Table 8.

Table 8. Demographics of Soldiers at first DEERS record, 2000-2006

Demographics	First DEERS (N=671,208) Column %
Gender	
Male	574,205 85.55%
Female	95,907 14.29%
Unknown	1,096 0.16%
Age (Mean = 26.37; SD ±1.62)	
<21	212,226 31.62%
21-25	186,367 27.77%
26-30	102,153 15.22%
31-35	77,050 11.48%
36-40	54,848 8.17%
>40	36,801 5.48%
Unknown	1,763 0.26%
Race/Ethnicity	
White	413,873 61.66%
African-American	147,133

Demographics	First DEERS (N=671,208) Column %
	21.92%
Hispanic	65,234 9.72%
Indian/Alaskan	5,871 0.87%
Asian/Pacific	24,596 3.66%
Other	12,673 1.89%
Unknown	1,828 0.27%
Marital Status	
Single	376,570 56.10%
Married	268,806 40.05%
Widowed/Divorced/Legally Separated	23,069 3.44%
Unknown	2,763 0.41%
Education	
< High School	33,946 5.06%
High School Grad/GED/Alt. Education	475,237 70.80%
Some College	29,407 4.38%
≥College degree	107,915 16.08%
Unknown	24,703 3.68%
Rank	
E1-E4	421,675 62.82%
E5-E6	102,737 15.31%
E7-E9	51,137 7.62%
Warrant	11,636 1.73%
Officer	84,023 12.52%
Unknown	--

Demographics	First DEERS (N=671,208) Column %
Number of Dependents	
Member Only	315,212 46.96%
Member + 1 dependent	91,247 13.59%
Member + 2 dependents	73,880 11.01%
Member + 3 dependents	73,276 10.91%
Member + 4 or more dependents	43,774 6.52%
Unknown	73,819 11.00%

Other

As referenced in our 2007 Annual report, paperwork was submitted 8 June 2007 to name Dr. Nicole Bell as the Principal Investigator for this grant. This request was approved and the modification was effective 5 October 2007.

On July 19, 2007, we submitted a summary report of findings and efforts under this project as well as a request for Continuing Review for our study protocol with the USARIEM Human Use Review Committee (HURC). We received approval following their review on July 27, 2007. A copy of the 2007 Continuing Review is attached to this report in Appendix E. Our 2008 Continuing review was submitted on June 30, 2008 and is currently under review. A copy of the approved 2008 Continuing Review will be provided in next year's report.

KEY RESEARCH ACCOMPLISHMENTS

- Documented and described the relative proportion of disabilities by major type over 25 years
- Described soldiers at risk for different types of disability as well as the type of compensation awarded for different types of disability and any temporal changes in these associations.
- Categorized the most common enlisted Army occupations according to their relative levels of physical demand and then tracked these occupational codes over time
- Determined unadjusted injury rates for soldiers within each level of physical occupational demand, and across individual occupations over a 27 year period.
- Described the demographic profile of soldiers in varying levels of occupational physical demand
- Evaluated the relationship between physical demands associated with enlisted Army occupations and injury or disability outcomes
- Investigated interactions between job demands and gender and health outcomes including hospitalizations for various causes and disability.
- Described demographic and other risk factors associated with mental health disability
- Assessed associations between demographic and hazard pay characteristics among soldiers who are discharged with a mental health disability

REPORTABLE OUTCOMES

Publications:

Bell NS, Schwartz CE, Harford TC, Hollander IE, Amoroso PJ. Temporal Changes in the Nature of Disability: U.S. Army Soldiers Discharged with Disability: 1981-2005. Disability and Health Journal, 2008 (in press).

Bell NS, Schwartz CE, Harford TC, Hollander IE, Amoroso PJ. The Changing Profile of Disability in the U.S. Army: 1981-2005. Disability and Health Journal, 2008; 1(1): 14-24.

Technical Reports:

Hollander IE, Bell NS, Sharp M. Physical Demands of Army Military Occupational Specialties: Constructing and Applying of a Crosswalk to Evaluate the Relationship between Occupational Physical Demands and Hospitalizations. T08-06. ADA 482364 Pending. Technical Report. US Army Research Institute for Environmental Medicine. May 2008.

Bell NS, Hollander IE, Williams JO, Amoroso PJ. A Tale of Two Disability Coding Systems: The Veterans Administration Schedule for Rating Disabilities (VASRD) vs. Diagnostic Coding Using the International Classification of Diseases, 9th Edition, Clinical Modification (ICD-9-CM). T08-02. ADA 476409. Technical Report. US Army Research Institute for Environmental Medicine. January 2008.

Presentations:

Bell NS, Schwartz CE, Harford TC, Hollander IE & Amoroso PJ. The Changing Profile of Disability in the U.S. Army: 1981-2005. American Public Health Association. 135th Annual Meeting: Politics, Policy and Public Health. Washington DC: November 3-7, 2007.

Bell NS, Schwartz CE, Harford TC, Hollander IE & Amoroso PJ. Temporal Changes in the Nature of Disability: US Army Soldiers Discharged with Disability, 1981--2005. American Public Health Association. 135th Annual Meeting: Politics, Policy and Public Health. Washington DC: November 3-7, 2007.

CONCLUSIONS

Disability is a significant problem for the US Army and rates are increasing steadily. Musculoskeletal disability in particular is increasing more rapidly than other types of disability: an understanding of why this is occurring is imperative. Moreover, certain demographic subgroups within the Army are at greater risk for permanent disability than others. Preliminary analyses suggest that physical job demands, as described in the Department of the Army Pamphlet 611-21, do not appear to explain much of the variation in disability. But, for men, demanding jobs do seem to be related to an increased risk for injuries, including on-the-job injury. There is also some evidence that certain occupational exposures, such as hostile fire and combat exposure, result in increased risk for certain mental health disabilities. But, other occupational exposures, such as parachuting, may be protective.

In light of our own findings as well as recent media attention towards the psychological health of soldiers, particularly deployed or returning deployed soldiers, future research should also be directed towards understanding mental health disability. Identification of prior hospitalizations and risk factors among soldiers who are ultimately discharged with a permanent disability can inform the development of targeted interventions to ultimately reduce the burden of mental health-related disability.

Several key findings from research completed this year are notable. These are summarized in bullets below:

*90% of all disability recorded from 1981-2005 is captured within the top five most prevalent types of disability: musculoskeletal (72%) neurological (6%), mental health (5%), cardiovascular system (4%) and respiratory (4%).

*Musculoskeletal disability rates are increasing rapidly (+2.5% per year); neurological and cardiovascular disability rates are decreasing (-1.3% and -10.0% annually, respectively), and respiratory and mental health disability rates did not change significantly.

*The greatest risk for musculoskeletal disability was experienced by female soldiers, soldiers who were between the ages of 21-35, white, of lower to mid-level enlisted ranks with relatively short service tenure, and by soldiers without a college education.

*Compensation awards associated with permanent disability from the Army varied by disability type: Overall, 77% (N=83,320) received separation with severance pay, 15% (N=16,107) received a permanent disability retirement and 8% (N=8,692) received separation without benefits. Separation with severance pay was the largest and fastest growing disability disposition for all disabilities and for musculoskeletal disability specifically.

*Lighter physically-demanding jobs have higher unadjusted rates of any-cause hospitalizations whereas heavier physically-demanding occupations have higher unadjusted rates of injury-specific hospitalizations.

*Unadjusted rates suggest that on-duty serious accidents (those resulting in an injury hospitalization) occur more frequently among heavy physically-demanding jobs.

*Preliminary evidence suggests gender interactions such that men in physically demanding jobs are at increased risk for injury-related hospitalizations and for on-duty accidents resulting in hospitalizations. In contrast, women in physically demanding jobs are at increased risk for any cause hospitalization but not at increased risk for injury or on-duty accidents resulting in hospitalizations.

*The most common mental health disability categories from 1981-2005 were mood disorders (29%), psychotic disorders (24%), anxiety disorders (13%) and cognitive disorders (9%). The remaining 25% were distributed over several categories. Just under 10% of mental health disability appear to be combat related (9.5%).

*Enlisted soldiers discharged with a permanent mental health disability were more likely than those discharged with another type of disability to be male, older, “other” minority status (not white, black or Hispanic), single or previously married. They were also more likely to have served recently in the infantry, communications, health care, task specialist, support, and supply career fields and they were more likely to have received hazardous duty pay for hostile fire.

*Soldiers discharged with mental health disability were less likely to have received hazardous duty pay for parachuting or for foreign duty assignments. Compared to soldiers discharged without a permanent disability, soldiers with mental health disability were more likely to be older, single, in infantry, communications, health care, tech specialist, and support jobs. They were less likely to be in equipment repair or “non-occupational” groups and they were less likely to have received special pay for parachute duty or foreign assignment (these were protective factors). Hostile fire pay was not significantly associated with the outcome for this comparison.

*89% of soldiers with mental health disability had prior hospitalizations, compared with 66% of soldiers with other types of disabilities and 39% of soldiers with no recorded disability upon leaving the service. Risks are particularly high for mental health related hospitalizations but also for substance abuse, and for injury.

*Risk factors and patterns of mental health disability vary considerably between officers and enlisted.

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LIST OF APPENDICES

Appendix A – Bell NS, Hollander IE, Williams JO, Amoroso PJ. A Tale of Two Disability Coding Systems: The Veterans Administration Schedule for Rating Disabilities (VASRD) vs. Diagnostic Coding Using the International Classification of Diseases, 9th Edition, Clinical Modification (ICD-9-CM). T08-02. ADA 476409. Technical Report. US Army Research Institute for Environmental Medicine. January 2008.

Appendix B – Bell NS, Schwartz CE, Harford TC, Hollander IE, Amoroso PJ. The Changing Profile of Disability in the U.S. Army: 1981-2005. Disability and Health Journal, 2008; 1(1): 14-24.

Appendix C – Bell NS, Schwartz CE, Harford TC, Hollander IE, Amoroso PJ. Temporal Changes in the Nature of Disability: U.S. Army Soldiers Discharged with Disability: 1981-2005. Disability and Health Journal, 2008 (in press).

Appendix D – Hollander IE, Bell NS, Sharp M. Physical Demands of Army Military Occupational Specialties: Constructing and Applying of a Crosswalk to Evaluate the Relationship between Occupational Physical Demands and Hospitalizations. T08-07. ADA 482364 Pending. Technical Report. US Army Research Institute for Environmental Medicine. May 2008.

Appendix E – Approved Continuing Review for USARIEM No. H00-10y “Risk Factors for Discharge from the Army with a Permanent Disability.” July 2007.

Appendix A

U.S. Army
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Natick, Massachusetts

TECHNICAL REPORT NO. T08-02
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A TALE OF TWO DISABILITY CODING SYSTEMS: THE VETERANS ADMINISTRATION SCHEDULE FOR RATING DISABILITIES (VASRD) VS. DIAGNOSTIC CODING USING THE INTERNATIONAL CLASSIFICATION OF DISEASES, 9th EDITION, CLINICAL MODIFICATION (ICD-9-CM)

United States Army
Medical Research & Materiel Command

Approved for public release; distribution is unlimited.

The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or reflecting the views of the Army or the Department of Defense.

The investigators have adhered to the policies for protection of human subjects as prescribed in Army Regulation 70-25, and the research was conducted in adherence with the provisions of 32 CFR Part 219.

Any citations of commercial organizations and trade names in this report do not constitute an official Department of the Army endorsement of approval of the products or services of these organizations.

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13. ABSTRACT *(Maximum 200 words)*
Disability rates have increased by approximately 10% per year over the past 25 years. Little is known about the etiology, in part because Veterans Administration Schedule for Rating Disabilities (VASRD) codes are not clinical diagnoses. This report describes results from analyses linking VASRD disability codes to International Classification of Disease, 9th Rev., Clinical Modification (ICD-9-CM) clinical diagnoses captured in hospital administrative records during disability case processing. Results suggest that while the primary ICD-9-CM codes generally correspond logically to VASRD codes in the associated disability discharge records, some VASRD categories lack homogeneity, substantially reducing their value for research and surveillance purposes. "Infectious disease, immune disorder, or nutritional deficiency;" "hemic and lymphatic systems;" and "gynecological conditions and disorders of the breast" are either extensively heterogeneous or lack specificity which may result in only partial capture of cases with the same etiology in that particular VASRD group (e.g., breast disorders may logically be placed in more than one VASRD category). Primary clinical conditions experienced by soldiers discharged with "musculoskeletal" disabilities, the most common VASRD disability group, were pain in joint, lumbago, joint derangement, chondromalacia patellae, and osteoarthrosis--all diseases of the musculoskeletal system and connective tissue (ICD-9-CM 710-739). Overall concordance between ICD-9-CM clinical conditions and VASRD codes for "musculoskeletal" disability suggest good face validity. All ICD-9-CM diagnoses associated with the two major VASRD subgroups within "musculoskeletal" disability--"Injury" or "Disease"--fall within the ICD-9-CM 710-739 group suggesting there may be little clinical value in differentiating between "Injury" vs. "Disease." Future efforts should focus on assessing more current VASRD codes and should explore the link between secondary or comorbid clinical conditions and VASRD primary and secondary codes. Future research should explore the etiology of increased risk for musculoskeletal disability, particularly risk factors for lumbago and joint pain-the two most common clinical diagnoses.

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A TALE OF TWO DISABILITY CODING SYSTEMS: THE VETERANS ADMINISTRATION SCHEDULE FOR RATING DISABILITIES (VASRD) VS. DIAGNOSTIC CODING USING THE INTERNATIONAL CLASSIFICATION OF DISEASES, 9TH EDITION, CLINICAL MODIFICATION (ICD-9-CM)

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LIST OF ACRONYMS

ADS	Ambulatory Data System
BMI	Body Mass Index
CRO	Carded for Record Only
DMDC	Defense Manpower Data Center
DOA	Dead on Arrival
DoD	Department of Defense
ER	Emergency Room
ICD-9-CM	International Classification of Disease, 9th revision, Clinical Modification
MEB	Medical Evaluation Board
MEBITT	Medical Evaluation Board Internal Tracking Tool
PASBA	Patient Administration Systems and Biostatistics Activity
PEB	Physical Evaluation Board
TAIHOD	Total Army Injury and Health Outcomes Database
TDRL	Temporary Disability Retired List
VASRD	Veterans Administration Schedule for Rating Disabilities
VA	Veterans Affairs

EXECUTIVE SUMMARY

Disability rates have increased, on average, by approximately 10% per year for the past 25 years (7). Despite dramatic increases in disabilities and the costs associated with them, relatively little is understood regarding their etiology and natural history. In part, this may be due to the fact that the system for coding and describing disability is not clearly linked to medical diagnoses for the underlying clinical conditions. The Army uses the Veterans Administration Schedule for Rating Disabilities (VASRD) system for categorizing and coding permanent disability. This system is primarily focused on describing functional impairment due to a disease or injury. VASRD codes are thus not actual clinical diagnoses. While it is likely that certain patterns of VASRD codes will link directly to certain clinical diagnoses, it is not clear how directly comparable these codes are to the International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM) codes used in the U.S. to describe conditions resulting in hospitalizations or outpatient visits. It is also not clear how the VASRD codes will relate to clinical diagnoses and treatment in hospitalizations and outpatient clinics for injuries and diseases occurring prior to, but possibly related to, the disability discharge. Understanding the link between clinical diagnoses and functional impairment codes is essential to identifying risk factors for disability and documenting the natural history of disabling conditions.

This report details findings from our analysis of VASRD disability codes linked to corresponding ICD-9-CM clinical diagnoses from hospital records. The purpose of this report is to clarify and document the association between common VASRD codes and ICD-9-CM clinical diagnoses traditionally used only for inpatient and outpatient medical diagnosis coding.

In order to address the goals of this study, we linked disability discharge case files to a unique set of Army hospital-generated records created at the time of disability discharge. These records do not represent actual hospitalization admissions. They were created under Army administrative directive in order to facilitate the documentation of disability discharges among Army servicemembers. Up until about the year 2000, disability evaluations usually resulted in the generation of one of these administrative hospital records, referred to as “Carded for Record Only” (CRO) records. CRO records include ICD diagnoses based on a clinical review of the information contained in the disability files and are available electronically. While the disability hard copy files also include information on clinical diagnoses, the electronic disability data files do not retain these codes. Thus, without these electronically available CRO files, it would be very difficult to evaluate the clinical significance of VASRD codes on any large-scale basis.

Not all disability cases have these associated administrative records, but a sizable proportion of them do (approximately 1/2 of those during the study period). A comparison of those with a CRO record to those without, among Soldiers discharged with a permanent disability, revealed little difference in the demographic profiles. However, the proportion of disability cases with CRO records did vary somewhat by type of disability, ranging from 22.26% to 52.1% for different types of disability. The

VASRD groups least likely to have a CRO record were those discharged with a mental disorder disability followed by those within the infectious disease, immune disorder, or nutritional deficiency VASRD group. In contrast, disability related to the musculoskeletal system, auditory impairment and organs of special sense, or the respiratory system were most likely to have a CRO record.

We used these CRO records to characterize the clinical significance of the VASRD codes by linking the ICD-9-CM diagnoses listed in the hospital administrative records to the VASRD codes contained in the permanent disability files. VASRD codes may be grouped into 15 broad categories or broken down into increasingly detailed and smaller subcategories within each broad group. Our initial efforts to detail the clinical interpretation of the VASRD codes involved the exploration of commonly assigned ICD-9-CM codes for each of 15 broad VASRD groups. This allows us to better understand the major types of clinical diagnoses associated with overall disability, as well as changes in patterns of disease and injury over time among the entire population of disabled Soldiers. As a second step, we focused on the more detailed codes within the most common VASRD category: musculoskeletal conditions. Because the vast majority of disability is within this group and it is the fastest growing category of disability, it is important to assess the clinical implications of the more specific musculoskeletal VASRD subcategories. Finally, in order to address possible temporal changes in coding, we explore the frequency of top VASRD and top ICD-9-CM coding over time.

For most of the VASRD groupings, the corresponding ICD-9-CM diagnoses demonstrate good face validity. That is, the most commonly assigned ICD-9-CM codes in the hospital-generated CRO disability records do correspond logically to the VASRD codes in the associated disability discharge records. However, some of the VASRD groups lack homogeneity, which substantially reduces their value for research and surveillance purposes. For example, for categories of infectious disease, immune disorder, or nutritional deficiency; hemic and lymphatic systems; and gynecological conditions and disorders of the breast, there is a lot of variation in the types of clinical conditions associated with these broad VASRD groups. This extensive heterogeneity makes these VASRD groups less clinically interpretable and may suggest that aggregate analysis of disability within these groups is less useful for either surveillance or epidemiologic research. For example, the infectious disease, immune disorder, or nutritional deficiency VASRD codes group encompasses infectious diseases, autoimmune processes, and nutritional disorders that often have quite different etiologies. The most common ICD-9-CM diagnosis for this broad VASRD group was HIV infection. This was followed by lupus, an autoimmune disorder, and then by sarcoidosis, a disease with unclear etiology that may have infectious, environmental exposure and/or autoimmune etiology. The diversity of conditions and risk factors for the conditions contained in this VASRD group suggest that caution should be used when assessing changes in this VASRD group. Ideally, subgroup analyses should be undertaken for this group, as well as for diseases of the hemic and lymphatic systems and gynecological conditions and disorders of the breast. Like infectious disease, immune disorder or nutritional deficiency VASRD group, the gynecological and breast disorder group is heterogeneous, and ICD-9-CM conditions linked to this VASRD include conditions that may be experienced by men and women. For example,

abdominal pain was the third most common diagnosis. Since this VASRD group is reserved for women, presumably this refers to abdominal pain of pelvic origin. However, it is not obvious where men with abdominal pain would be placed, nor whether or not women with abdominal pain may appear in more than one VASRD group.

Musculoskeletal conditions are the most common cause for permanent disability discharge from the U.S. Army and have been for over two decades. The primary clinical conditions experienced by those hospitalized and ultimately discharged from the Army with a musculoskeletal disability condition were pain in joint, lumbago, joint derangement, chondromalacia patellae, and osteoarthrosis, which are all diseases of the musculoskeletal system and connective tissue (ICD-9-CM 710-739). The two major VASRD subgroups of musculoskeletal condition are "Injury" and "Disease." The ICD-9-CM diagnoses associated with either of these VASRD subgroups all fall within the ICD 710-739 group suggesting that the distinction in the VASRD subcategories for musculoskeletal condition ("Injury" vs. "Disease") may have diminished descriptive significance. However, the overall concordance between ICD-9-CM clinical conditions and VASRD codes for musculoskeletal disability suggest good face validity.

Musculoskeletal conditions are not only the most common reason for permanent disability discharge, they have been steadily increasing as a proportion of all disability discharges. Respiratory conditions, primarily associated with an asthma-related ICD-9-CM diagnosis, are also increasing as a proportion of the total disability cases.

Future research should explore the etiology of the increased risk for musculoskeletal disability and, in particular, risk factors for lumbago and joint pain—the two most common clinical diagnoses associated with this rapidly growing cause of disability. Specifically, risk factors for back- and knee- or other joint-related disability should be explored. The increased risk for these conditions may reflect changes in the vulnerability of the general population from which the Army draws its employees (e.g., decreased physical fitness in the general U.S. population) and concurrent increased BMI and higher body fat among Army recruits, or it could reflect changes in occupational exposures in the Army. For instance, some occupational specialties now must bear a great deal of equipment weight while marching or walking. Pilots now have greater head-supported mass due to greater ballistics head protection combined with specialty tools (e.g., night vision). All of these could contribute to increasing musculoskeletal disability. Finally, changes in health-seeking behaviors or disability evaluation seeking behaviors and/or changes on the part of providers and disability coordinators could result in changes in overall risk for certain conditions. All of these explanations require greater investigation in order to better understand and describe the underlying reasons for increased musculoskeletal disability.

Consideration from a policy perspective should be given to revising specific VASRD codes and the content of several groupings, such as infectious diseases, immune disorders, or nutritional deficiencies; diseases of the hemic and lymphatic system; and gynecological conditions and disorders of the breast, to improve

homogeneity and, therefore, interpretability of changes in frequencies or rates of disabilities within each of these groups.

INTRODUCTION AND BACKGROUND

Disability is a rapidly growing problem. Disability risk among Army Soldiers has increased seven-fold over the past 25 years. Between 1981 and 2005 the permanent disability discharge rate increased from 178/100,000 population to 1,262/100,000. In 2005 alone there were over 7,000 Soldiers discharged from the Army with a permanent disability (7).

The economic costs of disability to the U.S. military and the Veteran's Administration are shocking. In Fiscal Year 2005 alone, the Department of Defense (DoD) paid disability-retired Army Soldiers nearly half a billion dollars ($474 million) and a total of $1.25 billion in benefits payments to all disabled military service members (2, 9, 33). While total medical care costs for disabled Army Soldiers are unknown, Veterans Affairs (VA) facility treatment costs for Army Soldiers with a medical discharge between 1986 and 1995 were estimated at $124 million in 2001 alone. The cost of running the VA medical system is on the order of 25 billion annually, with most of the care rendered to disabled veterans (2, 34). It seems likely that these costs will only increase once Soldiers with disabilities related to Operation Iraqi Freedom are processed and enter the DoD and VA systems.

Beyond the direct financial cost of disability, there are also substantial indirect costs and non-economic losses that are more difficult to quantify. Disabled Soldiers who leave the work-force prematurely face wage losses among both the disabled individuals and any caretakers. Their quality of life may be diminished. The disabled Soldier may be unable to perform household tasks or manage personal care. The potential decreased quality of life due to the disabling condition is not factored in to the costs of disability (14, 22). Recruitment and replacement training costs, as well as the costs of losing experienced employees, are also not estimated. Also hard to quantify are the costs associated with the Army's investment in training and maintaining Soldiers whose careers are later cut short by a disability. Medical care for the condition prior to disablement and administrative costs associated with evaluating and processing the disability are not well documented.

Despite the dramatic increases in disabilities over time and the costs associated with them, relatively little is understood regarding their etiology and natural history. In part this may be due to the fact that the primary system for coding and describing disability is not clearly linked to the medical care system and to clinical diagnoses. The Army Physical Evaluation Board (PEB), part of the disability evaluation process, uses the Veterans Administration Schedule for Rating Disabilities (VASRD) to categorize and describe disability. While International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM) clinical diagnoses related to the disability medical evaluation process, as well as other pertinent medical data, are used by coders to create the disabled Soldier's VASRD code, the PEB electronic disability data file does not include the actual ICD-9-CM clinical diagnoses used by coders to help determine the VASRD code. The VASRD system used to code each type of permanent disability was created to describe functional impairment due to a disease or injury, and thus the VASRD codes

describing a particular Soldier's disability are not actual clinical diagnoses. While it is likely that certain patterns of VASRD codes will link directly to certain clinical diagnoses, it is not known to what extent these codes are comparable to ICD-9-CM codes that are used to describe conditions resulting in hospitalizations or outpatient visits. It is also not clear how these VASRD codes will relate to clinical diagnoses and treatment in hospitalizations and outpatient clinics for injuries and diseases occurring prior to, but possibly related to, the disability discharge.

In order to effectively study the natural medical history of disability and to identify important risk factors and effect modifiers of disability, it is important to understand the clinical significance of the major types of disability. This is not possible without linking the functional impairment codes represented by VASRD broad and specific codes to clinical diagnoses represented by ICD-9-CM codes.

The primary purpose of this report is to illuminate and document the association between major VASRD codes and ICD-9-CM clinical diagnoses. Because there are no electronically available clinical diagnoses in the disability file, we address this aim by linking disability data to a special category of administrative hospital records associated with a large portion of disability cases between 1984 and 1999. These hospital administrative files include ICD-9-CM diagnoses related to the disability evaluation process and allow us to document the patterns of ICD-9-CM primary diagnoses associated with each of the VASRD code groups. A secondary goal of the analyses described in this report is to explore temporal variation in coding patterns. In addition to an overall assessment of the agreement between VASRD codes and logical ICD-9-CM diagnoses, we explore possible temporal changes in coding practices by examining variations over time in ICD-9-CM coding associated with the most frequent VASRD code group (musculoskeletal conditions).

We hypothesize that VASRD groupings are homogeneous and meaningful and that there will thus be strong associations between each of the VASRD groups and a corresponding, logical, ICD-9-CM diagnostic code group. This might be considered evidence of good face validity for the VASRD codes. Failure to document such agreement would suggest that some or all of the VASRD groups are not specific enough to support aggregate analysis and that analysis of broad VASRD groups may lack clinical relevancy. It could also suggest that the VASRD codes themselves ought to be reviewed with careful thought given to either clarifying use of the VASRD codes for different types of disabilities and/or adding or deleting VASRD codes to improve specificity.

METHODS

DATA

The Total Army Injury and Health Outcomes Database (TAIHOD) was developed to provide ready access to research data in order to answer questions related to the health and well-being of active duty and former active duty Army Soldiers (4-6). The TAIHOD, comprised of data from multiple Department of Defense agencies, is regularly updated with new files, error checked, and linked to existing data. Unique identifiers allow for the linkage of the diverse health and demographic data within these files at the level of the individual Soldier. The availability of this linked information in the TAIHOD allows us to explore associations between coded disability type and related hospitalization clinical diagnoses for the entire Army population over a long span of time. The specific TAIHOD components used in this analysis include demographic data from the Army's Defense Manpower Data System (DMDC), Army hospitalization administrative files, and electronic disability board records from the U.S. Army Physical Disability Agency.

Demographic Covariates

Demographic covariates from the DMDC used in this analysis included gender, rank, age, race, marital status, education, and time in service. Age is presented in years, and total time on active duty is presented in months. The DMDC race and ethnicity categories include white, black, Hispanic, Native American/Alaskan Native, Asian/Pacific Islander, and other." Marital status includes single (never-married), married, and previously married (i.e., widowed or divorced). Education is coded as less than high school degree, high school (or degree equivalent), some college, and completed college or above. Rank for enlisted personnel was coded as Junior (E1-E4), Mid-Level (E5-E6) and Senior (E7-E9) and for officers as Warrant Officer (W1-W5), Junior Officers O1-O3, Mid-Level Officers O4-O5 and Senior Officers O6O11.

Hospital Data (ICD-9-CM Diagnoses)

ICD-9-CM diagnoses were obtained from administrative hospitalization records that were often created as part of the disability evaluation process. Hospital-generated records originate in the Individual Patient Data System maintained by the Patient Administration Systems and Biostatistics Activity (PASBA) (http://www.pasba.amedd.army.mil). The hospital-generated ICD-9-CM data used for these analyses are from records created in Military Treatment Facilities (hospitals) and are created in the same Standard Inpatient Data Record format as inpatient hospitalizations, but do not represent actual hospital admissions. Rather these data are from a specially produced administrative record created in order to facilitate surveillance of disability-related discharge from the Army. These records have no direct link to a specific hospital admission to treat a condition. They were created for administrative purposes and are referred to as "Carded for Record Only" or CRO records.

Historically, CRO records were created in order to track hospital patient-care resources used to process disability discharge cases and to facilitate surveillance of other medical events of unique importance or command interest that involved hospital personnel but which were not actually true hospital admissions (e.g., patients who were dead on arrival [DOA], or who died in the emergency room [ER]). Until 1996, CRO records were required on all ER or DOA deaths. Although the CRO record-keeping system was still in use up until 2000, the number of CRO records available began to fall off after a 1996 policy change. It was in that general time period that the Outpatient Ambulatory Data System (ADS) was implemented. Policy-makers believed that the implementation of the electronic ADS system diminished the need to track ER deaths. The ADS, while making available important information, lacks some of the information contained in hospital files, including cause of injury coding. In addition, it does not include information that directly links clinical diagnoses to a specific disability case. Thus, the policy change resulted in a loss of potential data available for research on both causes of injury when the person arrives at the hospital DOA or dies in the hospital ER, and on the clinical diagnoses associated with disability.

While the change in policy limits research on clinical causes of disability after 2000, data up until 2000 provide a robust source of information that may be used for the purposes of this study. CRO records were used to record PEB actions resulting in discharge from service for disability. The information for creation of these CRO records came from review of hard copy Medical Evaluation Board (MEB) and PEB records. The Medical Evaluation Board Internal Tracking Tool (MEBITT) was initiated in 1999 to record details of MEBs, including ICD-9-CM codes (6). While providing an alternate and potentially more robust source of this data than CRO records, the MEBITT data have been criticized because of inaccuracies and reported poor training of the PEB Liaison Officers (10). In addition, they are only available for more recent years. The CRO records are thus an immensely useful though underutilized complementary data source to Army disability agency records and were the most reliable source of disability-related ICD-9-CM diagnosis codes prior to 2001. Although they do not represent true hospital admissions, CRO records provide important clinical information, most importantly ICD-9-CM codes (which are not present in the electronic physical evaluation disability database) and cause-of-injury codes when the diagnosis is an acute injury. Unfortunately, because the recording of the CRO records for tracking disability and other cases was considered superfluous once the implementation of the ADS and the MEBITT systems were completed (1996-2001), CRO records were phased out, thereby eliminating this rich source of information on disability cases after about 2000.

While the CRO files do provide important information not elsewhere available in electronic analyzable format, they are not available on all disability cases. Approximately 1/2 of Soldiers who have been discharged from the Army since 1971 due to disability have CRO records in the hospital database during the years in which CRO records were still being used. It is not clear why some disability cases do not have a corresponding CRO record. One aim of these analyses is to compare the demographic characteristics of disability cases with CRO records to those without to see if this reveals any important patterns or differences between disabled Soldiers with and without CRO records.

Disability Data

Disability data from the U.S. Army Physical Disability Evaluation process derive from two review boards that evaluate a potentially disabled Soldier's medical status. First, the MEB assesses the degree of the Soldier's disability using medical standards (IAW AR 40-501). Second, the PEB assesses the impact of the disability on the Soldier's ability to perform his or her military duties (28) (https://www.perscom.army.mil/tagd/pda/pdapage.htm). These review boards may find a Soldier permanently disabled, or may find that he or she is fit to return to duty. If the Soldier's condition is temporary or unstable, the PEB may assign the Soldier to the Temporary Disability Retirement List (TDRL). TDRL cases are reevaluated at least every 18 months and must be given a final disposition within 5 years. Soldiers on TDRL may differ from those never placed on TDRL. Because the process of evaluation and reevaluation of TDRL cases before final disposition is made can be quite long, we excluded TDRL cases from this analysis (reduces total population by approximately 8%).

Upon completion of the review process, the disabled Soldier may be retired permanently, or separated with or without severance pay. The MEB includes ICD clinical diagnoses, though it does not include the VASRD code, since this is assigned as part of the next step: the PEB process. Some of the clinical information from the MEB is now being collected and maintained in an electronic analyzable form (i.e., MEBITT), but these are only available for 2001 and later and not a current component of the TAIHOD. In addition, as noted above, there are limitations to the MEBITT data. As such, these data are not used in this analysis.

The PEB data include a VASRD code but no clinical ICD diagnoses. The TAIHOD includes all PEB records for the years 1981-forward, with information on dates of disability and the findings of the disability boards (including disability-rating percentages), but these files lack clinical diagnostic data. To overcome this obstacle to comparing the VASRD codes to clinical ICD-9-CM codes, we reviewed data from all available CRO hospitalization records (described above under Hospital Data). CRO hospitalization records include a unique identifier and date and can thus be linked to unique identifiers present in the PEB disability file.

Type of Disability

The VASRD codes are organized into 16 body/organ system groups that may be thought of in a very general sense as causes or major types of disability. These are the following: Musculoskeletal System; Respiratory System; Cardiovascular System; Digestive System; Genitourinary System; Gynecological Conditions and Disorders of the Breast; Hemic and Lymphatic Systems; Skin; Endocrine System; Neurological Conditions and Convulsive Disorders; Mental Disorders; Impairment of Auditory Acuity; Other Sense Organs; Organs of Special Sense (Eye); Infectious Disease, Immune Disorders and Nutritional Deficiencies; Dental and Oral Conditions (Table 1). Due to the relatively small number of "other" sensory organ disability cases, we collapsed disabilities related to the ear with disabilities of "other sense organs" (excluding conditions occurring to the eye) yielding a total of 15 VASRD broad groups. Each of

these broad groupings can be further divided into increasingly more detailed categories and codes. For example, musculoskeletal conditions (the most common VASRD group among permanently disabled Soldiers) actually include 100 sub-codes.

Table 1. The broad classifications for permanent disability currently used by the Army.

38 C.F.R. 4 Subpart B (2006)	Category	Description
§4.71a	Musculoskeletal System	Includes conditions of the upper and lower extremities, inflammatory conditions, joint replacements, fibromyalgia, and spinal disorders.
§4.84a	Organs of Special Sense (Eye)	Includes vision loss, glaucoma, and other eye disorders.
§4.87	Impairment of Auditory Acuity (Ear)	Includes auditory-related disorders such as hearing loss and tinnitus.
§4.87a	Other Sense Organs	Includes loss of smell and taste.
§4.88b	Infectious Diseases, Immune Disorders, Nutritional Deficiencies	Includes infectious disease and immunological compromising disorders such as Lupus, HIV, and Chronic Fatigue Syndrome.
§4.97	Respiratory System	Includes infections, arthritis, and a variety of other systemic disorders.
§4.104	Cardiovascular System	Includes conditions of the heart and vascular system.
§4.114	Digestive System	Includes inflammations and infections, pancreatic disorders, obstructive conditions, and other dysfunctions such as ulcers.
§4.115	Genitourinary System	Includes urinary system problems and kidney disorders.
§4.116	Gynecological Conditions and Disorders of the Breast	Includes gynecological or breast cancer, endometriosis, gynecological diseases, injuries, or removal.
§4.117	Hemic and Lymphatic Systems	Includes anemia, leucopenia, leukemias, and lymphomas.
§4.118	Skin	Includes eczema, psoriasis, and a variety of other dermatological and urticarial disorders.
§4.119	Endocrine System	Includes diabetes, adrenal disorders, and thyroid conditions.
§4.124a	Neurological Conditions and	Includes neurogenic muscular conditions, degenerative disorders, demyelinating

	Convulsive Disorders	disorders, residuals of cardiovascular accidents and traumatic brain injury, seizures, and peripheral nerve dysfunctions.
§4.130	Mental Disorders	Includes most psychiatric conditions except personality disorders and conditions related to substance abuse.
§4.150	Dental and Oral Conditions	Includes tooth and mandible loss.

VASRD codes have sometimes been modified, dropped or new codes added over the study period. Changes do not affect the 15 broad groupings we used, but do affect subcodes within these broader VASRD categories. To simplify our efforts, these analyses rely on only the currently used codes. In the final section of this report, part IV, we explore temporal changes in VASRD coding, as well as underlying ICD-9-CM codes.

STUDY POPULATION: SELECTION OF CASES

DoD Directive 1332.18 defines disability as "Separation from the Military Service by Reason of Physical Disability" (1996). Title 10, U.S. Code, Chapter 61. DoD Directive 1332.18 outlines the requirements and procedures for separations due to a physical disability with the primary requirement being that the Soldier must be unfit to carry out duties of his or her rank, office, or grade due to a physically disabling condition that substantially limits or precludes fulfillment of the purpose of their active-duty employment. Once it is clear that a Soldier's physical or mental health conditions will make their return to active duty unlikely, Soldiers are referred to an MEB. The MEB reviews all available medical and occupational evidence and makes a recommendation regarding the medical fitness of the individual to perform the duties of their military occupational specialty. A second evaluation is then performed by the PEB. The PEB determines whether or not the condition is stable (no further improvement expected). Soldiers with stable disabling conditions are eligible for a permanent disability discharge. Confirmed permanent disabilities with a record of discharge from the Army between 1984-1999 were used for this analysis of VASRD codes. These cases were then matched to the DMDC in order to obtain demographic information. Subjects were required to have a matching DMDC file occurring within 1 year of the disability date. These matching permanent disability cases comprise the initial study population (N=67,410). These cases were then linked to the PASBA hospital files in order to identify matching CRO records. About half (49%, N=33,322) of the overall population had a matching CRO file. Most analyses of VASRD codes are conducted with the 33,322 disability discharged Soldiers who had CRO hospital records.

ANALYSIS

For every Soldier with a permanent disability discharge from the Army, we searched hospital data files and, where available, captured his or her last disability-

related CRO hospital record. Because these analyses support a larger study, the study cohort was first identified in 1981. Moreover, CRO data are generally not available before 1980 and not consistently used before 1984. We began exploring hospital records occurring in 1980 or later in order to improve our ability to capture disability hospital evaluations occurring up to a year prior to the earliest disability case in our study cohort.

Frequency distributions are used initially to describe the proportions of VASRD groups with corresponding CRO records overall and by year. Chi-square analysis is used to compare the demographic profile of disability cases with a CRO record to those without. For some comparisons, odds ratios and corresponding 95% confidence intervals are also reported.

Frequency distributions are also used to describe common ICD-9-CM codes associated with overall VASRD groups and, for musculoskeletal VASRD disabilities, subordinate codes. A final component of the analysis explores variations in the frequency distributions of ICD-9-CM codes associated with specific VASRD codes by era (1984-1989, 1990-1994, 1995-1999).

Most analyses were conducted using SAS versions 8.2 and 9 (SAS Institute, Cary, NC). EpiInfo Version 6 (Centers for Disease Control and Prevention, Atlanta, GA) was also used for assessing odds ratios and exact 95% confidence intervals for select demographic comparisons. All analyses for this project adhere to the policies for the protection of human subjects as prescribed in Army Regulation 70-25, and with the provisions of 45 CFR 46.

RESULTS

PART I. LINKING TO ICD-9-CM CLINICAL DIAGNOSTIC CODES

While not all disabled Soldiers were evaluated in a hospital setting and CRO records are not available for all cases, approximately 50% of Soldiers discharged with a permanent disability between 1981 and 1999, the primary years in which CRO records were generated, did have a CRO record associated with their PEB disability evaluation. These records provide an opportunity to evaluate the link between clinical diagnoses and disability functional diagnostic groupings. Because not all Soldiers receive a CRO record and the system for coding this changed over time, this section reports findings from analyses of temporal changes in the relative proportion of disability cases receiving a CRO, variations across specific types of disability, and it compares the demographic composition of disability cases with CRO to those without.

A. The Proportion of Disability Cases with Corresponding CRO Hospital Records: Exploration of Temporal Variations and Variations Across Specific Types of VASRD Codes

Administrative changes in hospital record keeping practices resulted in a tapering off of available CRO records after 1996. Figure 1 shows the percentage of disability cases with a CRO record by year of disability discharge. It is not clear why the proportion of cases with a CRO record increased during most of the study period. It may be because surveillance was a major reason for maintaining the CRO system and disability rates were increasing during this time period, resulting in greater scrutiny and efforts to improve reporting via CRO records.

Figure 1. Percent of the disability population with a disability-related CRO Hospital Record, 1984-1999

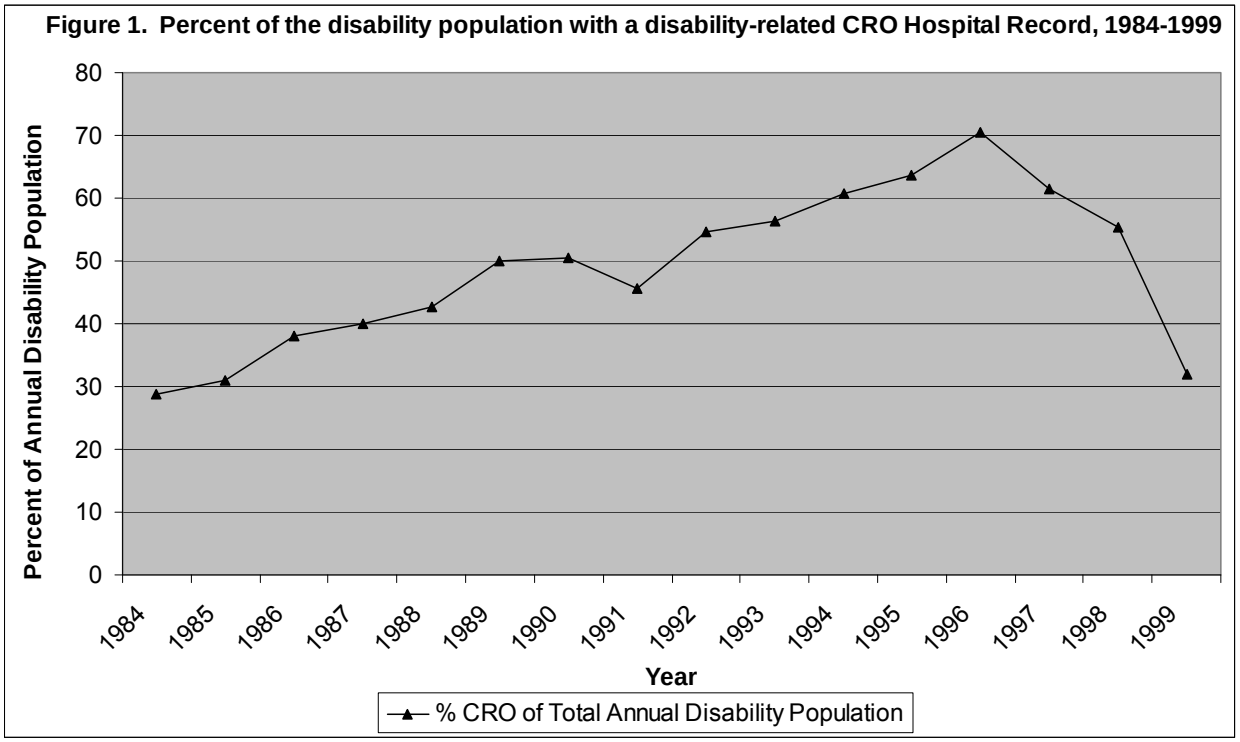


Table 2 shows the proportion of permanent disability cases by major VASRD group with a corresponding matching CRO hospital record. The proportion of disability cases with a CRO record varies somewhat by type of disability, ranging from 22.26% to 52.1%. The VASRD groups least likely to have a CRO record were those discharged with a mental health disorder followed by an infectious disease, immune disorder, or nutritional disease. Musculoskeletal, diseases of the ear and other sensory organs, and respiratory disabilities were all relatively more likely to have an associated CRO hospital record.

Table 2. Proportion of VASRD group with a CRO hospital record associated with a disability evaluation, 1984-1999.

Category	Percent with a CRO Hospital Record
Musculoskeletal system (N=48,120)	52.10%
Ear and other sense organs (N=453)	51.66%
Respiratory system (N=2,646)	47.20%
Skin (N=818)	43.64%
Missing (N=501)	43.31%
Neurological conditions and convulsive disorders (N=4,180)	42.15%
Endocrine system (N=1,309)	41.86%
Eye (N=873)	40.09%
Dental and oral conditions (N=30)	40.00%
Cardiovascular system (N=3,271)	38.80%
Digestive system (N=1,143)	38.15%
Gynecological conditions and breast disorders (N=92)	38.04%
Genitourinary system (N=512)	34.96%
Hemic and lymphatic systems (N=302)	27.48%
Infectious diseases, immune disorders, and nutritional deficiencies (N=545)	26.06%
Mental disorders (N=2,615)	22.26%

B. The Demographic Profile of Disability Cases with CRO Versus Disability Cases Without a CRO Record

Of the 67,410 Soldiers who received a permanent disability discharge between 1981 and 1999, 48.25% (N=32,524) had a prior disability-related hospital record. It is not clear why some disabled Soldiers have a CRO record documenting the evaluation process and why some do not. In order to assess the generalizability of the findings presented in this report, it is important to clarify whether those with a CRO record are similar to those who do not have a CRO record. The results, detailed below suggest that there is little to no difference between Soldiers discharged with a disability who have a CRO record and those discharged with a disability and no CRO record.

Soldiers with CRO records have slightly shorter total time on active service and are slightly though negligibly younger than those without a CRO record at the time of their discharge. The average time in service for disabled Soldiers who do not have a CRO record is 78.9 months (median of 54 months with a range of 420) compared to 74.8 months (median of 54 months with range of 420) for those with a CRO. The mean age for Soldiers without a CRO record was 27.8 (median=26), and the mean age for those with a CRO record was 27.4 (median=26) (data not shown).

Tables 3-4 below display results from Chi-square analysis of nominal demographic variable comparisons between Soldiers with and without CRO records.

Table 3 displays racial and ethnic differences. Large samples result in statistically significant differences between the groups, though actual differences in proportions are nearly negligible.

Table 3. Racial and ethnic composition of Soldiers discharged with a permanent disability between 1984-1999, stratified by presence of CRO record for disability evaluation.

Frequency	No CRO N=34,858 (Column %)	Yes CRO N=32,508 (Column %)	Total N=67,366 (%)
White	23674 (67.9%)	22095 (68.0%)	45,769 (67.9%)
Black	8402 (24.1%)	7976 (24.5%)	16,378 (24.3%)
Hispanic	1351 (3.9%)	1147 (3.5%)	2,498 (3.7%)
Indian/Alaskan Native	222 (0.6%)	168 (0.5%)	390 (0.6%)
Asian/Pacific Islander	467 (1.3%)	412 (1.3%)	879 (1.3%)
Other	742 (2.1%)	710 (2.2%)	1,452 (2.2%)

Chi-square=11.88, p<.05. Frequency missing=44.

As Table 4 below describes, there is little difference between the educational attainment of CRO and non-CRO disability cases. CRO cases were slightly more likely to have a high school degree or equivalent, but slightly less likely to have either less than a high school degree or some college education, or a college degree than non-CRO cases.

Table 4. Educational attainment of Soldiers discharged with a permanent disability between 1984-1999, stratified by presence of CRO record for disability evaluation.

Frequency	No CRO N=34,645 (Column %)	Yes CRO N=32,375 (Column %)	Total N=66,920 (%)
Less than high school	938 (2.7%)	455 (1.4%)	1,393 (2.1%)
High school or equivalent	28,894 (83.4%)	28.327 (87.8%)	57,221 (85.5%)
Some college	2429 (7.0%)	1729 (5.4%)	4,158 (6.2%)
College degree or greater	2384 (6.9%)	1764 (5.5%)	4,148 (6.2%)

Chi-square=300.1, p<.001. Frequency missing=490.

There were some slight variations in probability of having a CRO record across different levels of occupational rank (Table 5). Lower ranking enlisted were slightly more likely than higher ranking enlisted and officers to have a CRO record. Compared to E1-E4, E7-E9 odds of CRO were 0.65 (95% CI=0.61-0.70), Warrant Officer OR was 0.85 (95% CI=0.71-1.01), O1-O3 OR was 0.79 (95% CI=0.71-0.88), O4-O5 OR was 0.60 (95% CI=0.51-0.72), and O6-O11 was 0.40 (95% CI=0.29-0.56).

Table 5. Distribution of rank for Soldiers discharged with a permanent disability between 1984-1999, stratified by presence of CRO record for disability evaluation.

Frequency	No CRO N=34,876 (Column %)	Yes CRO N=32,523 (Column %)	Total N=67,399 (%)
E1-E4	21,013 (60.3%)	20,307 (62.4%)	41,320 (61.3%)
E5-E6	9,643 (27.7%)	9,434 (29.0%)	19,077 (28.3%)
E7-E9	2,559 (7.3%)	1,610 (5.0%)	4,169 (6.2%)
Warrant Officer	297 (0.9%)	243 (0.8%)	540 (0.8%)
O1-O3	870 (2.5%)	666 (2.1%)	1,536 (2.3%)
O4-O5	356 (1.0%)	208 (0.6%)	564 (0.8%)
O6-O11	136 (0.4%)	53 (0.2%)	189 (0.3%

Chi-square=256.3, p<.001. Frequency missing=11.

Men were slightly more likely than women to have a CRO hospital record (Table 6). Permanently disabled men in the study population were 15% more likely than women (OR=1.15, 95% CI=1.11-1.20) to have a CRO record.

Table 6. Gender of Soldiers discharged with a permanent disability between 1984-1999, stratified by presence of CRO record for disability evaluation.

Frequency	No CRO N=34,865 (Column &)	Yes CRO N=32,500 (Column %)	Total N=67,365 (%)
Male	28,946 (83.0%)	27,608 (85.0%)	56,554 (84%)
Female	5,919 (17.0%)	4,892 (15.1%)	10,811 (16.1%)

Chi-square=46.3, p<.001. Frequency missing=45.

Table 7 shows that married Soldiers and formerly married Soldiers were slightly more likely than single (never married) Soldiers to have a CRO record. Married and

formerly married odds of CRO, compared to single Soldiers, was 1.07 (95% CI=1.04-1.11)

Table 7. Marital Status of Soldiers discharged with a permanent disability between 1984-1999, stratified by presence of CRO record for disability evaluation.

Frequency	No CRO N=34,356 (Column %)	Yes CRO N=31,914 (Column %)	Total N=66,270 (%)
Single (never married)	13,174 (38.4%)	11,726 (36.7%)	24,900 (37.6%)
Married	19,733 (57.4%)	18,794 (58.9%)	38,527 (58.1%)
No longer married	1,448 (4.2%)	1,394 (4.4%)	2,842 (4.3%)

Chi-square=19.2, p<.001. Frequency missing=1,141.

PART II: THE ASSOCIATION BETWEEN MAJOR VASRD GROUPS AND ICD-9-CM CLINICAL DIAGNOSES

In order to evaluate the clinical relevancy of a VASRD diagnosis, primary ICD-9-CM diagnoses from CRO records are linked to the VASRD code for each permanently disabled Soldier with a CRO record. The following tables, figures, and results focus exclusively on just the 32,524 permanent disability discharge cases with a matching CRO record. Tables 8a-8o display the top ten primary ICD-9-CM diagnoses associated with each major VASRD group among those cases that had an associated CRO record, respectively. The relative proportion of cases with that particular ICD-9-CM diagnosis is also provided.

A. Most Frequent ICD-9-CM Diagnoses Within Each of the 15 Major VASRD Groups

The ICD-9-CM diagnoses most often associated with VASRD musculoskeletal conditions are displayed in Table 8a . All of the top ICD-9-CM diagnostic conditions for this VASRD group fall within the “Diseases of the Musculoskeletal System and Connective Tissue” (710-739) ICD-9-CM Codes. Six out of the top ten diagnoses fall specifically within “Arthropathies and related disorders“ (710-719).

Joint pain, or arthralgia, was the most commonly assigned primary diagnosis among Soldiers discharged with a musculoskeletal disorder disability VASRD code. Joint pain may result from a number of causes such as trauma, overuse, autoimmune, and other disorders. Arthralgia may be indicative of a number of different underlying clinical conditions including, but not limited to, arthritis, osteoarthritis, gout, fibromyalgia, autoimmune disorders such as lupus, bursitis, tendonitis, and acute injury or trauma (16).

Lumbago, or unspecified low back pain, was the second most commonly occurring ICD-9-CM diagnosis. Two of the top ten conditions are back-related diagnoses, and two are problems related to the knee (pain or injury). Other diagnoses are nonspecific and may also, in some cases, be related to the knee or back. Thus, the total morbidity associated with knee and back problems cannot be fully enumerated.

Table 8a. The 10 most common ICD-9-CM primary diagnoses associated with Musculoskeletal System VASRD Group, 1984-1999.

ICD-9-CM code (number and title)	Frequency	Percent of total*
719.4 Pain in Joint	4,378	17.46%
724.2 Lumbago	3,358	13.40%
718.8 Joint Derangement, Not Elsewhere Classified	1,057	4.22%
717.7 Chondromalacia of Patellae	910	3.63%
715.9 Osteoarthrosis, Unspecified	844	3.37%
729.5 Pain in Limb	762	3.04%
716.1 Traumatic Arthropathy	706	2.82%
717.8 Other Internal Derangement of Knee	621	2.48%
722.1 Displacement of Thoracic or Lumbar Intervertebral Disc w/o Myelopathy	613	2.45%
733.1 Pathological Fracture	530	2.11%

* Percents are given out of the total number of musculoskeletal system disability cases with a disability-related CRO hospital record (N=25,069).

Table 8b displays ICD-9-CM diagnoses most commonly associated with a neurological disability. Epilepsy (ICD-9-CM code 345) was the most common diagnosis comprising at least 7.6% of the total neurological disability cases with a prior hospitalization (ICD-9-CM codes 345.9 and 345.1), followed by migraine with 5.3%.

Table 8b. The 10 most common ICD-9-CM primary diagnoses associated with Neurological Conditions and Convulsive Disorders VASRD Group, 1984-1999.

ICD-9-CM code (number and title)	Frequency	Percent of total*
346.9 Migraine, Unspecified	94	5.33%
780.3 Convulsions	86	4.88%
608.9 Unspecified Disorder of Male Genital Organs	84	2.77%
345.9 Epilepsy, Unspecified	77	4.37%
789.0 Abdominal Pain	75	4.26%
784.0 Headache	65	3.69%
345.1 Generalized Convulsive Epilepsy	56	3.18%
355.8 Mononeuritis of lower limb, Unspecified	48	2.72%
354.2 Lesion of Ulnar Nerve	46	2.61%
355.3 Lesion of Lateral Popliteal Nerve	36	2.04%

* Percents are given out of the total number of neurological condition and convulsive disorder disability cases with a disability-related hospital record (N=1,762).

Table 8c displays the most common ICD-9-CM diagnoses associated with cardiovascular system disability. The majority of cardiovascular disability cases were diagnosed with arteriosclerotic heart disease (414.0, 414.9) (21% of all the top ten cardiovascular disability cases have one of these two clinical diagnoses). Most cardiovascular disability cases have a corresponding ICD-9-CM diagnosis that is consistent with cardiovascular disease. However, the second and third most common diagnoses for Soldiers ultimately discharged with primary VASRD code of cardiovascular disability were actually related to neurological and/or musculoskeletal disorders.

Table 8c. The 10 most common ICD-9-CM primary diagnoses associated with Cardiovascular System VASRD Group, 1984-1999.

ICD-9-CM code (number and title)	Frequency	Percent of total*
414.0 Coronary Atherosclerosis	228	17.97%
733.1 Pathological Fracture	121	9.54%
443.0 Raynaud's Syndrome	75	5.91%
729.5 Pain in Limb	74	5.83%
733.9 Other and Unspecified Disorders of Bone and Cartilage	58	4.57%
414.9 Chronic Ischemic Heart Disease, Unspecified	35	2.76%
453.8 Venous Embolism and Thrombosis of Other Specified Veins	29	2.29%
401.9 Essential Hypertension, Unspecified	27	2.13%
782.0 Disturbance of Skin Sensation	24	1.89%
429.2 Cardiovascular Disease, Unspecified	22	1.73%

* Percents are given out of the total number of cardiovascular system disability cases with a disability-related CRO hospital record (N=1,269).

The vast majority of respiratory-related disability is attributable to asthma (Table 8d). Unspecified and extrinsic asthma (493.9 and 493.0) together describe 67% of the top ten respiratory disability cases.

Table 8d. The 10 most common ICD-9-CM primary diagnoses associated with Respiratory System VASRD Group, 1984-1999.

ICD-9-CM code (number and title)	Frequency	Percent of total*
493.9 Asthma, Unspecified	707	56.61%
493.0 Extrinsic Asthma	131	10.49%
135 Sarcoidosis	42	3.36%
496 Chronic Airway Obstruction, NEC	37	2.96%
518.8 Other Diseases of Lung	30	2.40%
519.1 Other Diseases of the Trachea and Bronchus. NEC	30	2.40%
780.5 Sleep Disturbances	16	1.28%
786.0 Dyspnea and respiratory abnormalities	15	1.20%
786.5 Chest Pain	15	1.20%
519.9 Unspecified disease of respiratory system	14	1.12%

* Percents are given out of the total number of respiratory disability cases with a disability-related CRO hospital record (N=1,249).

Table 8e describes the most common ICD-9-CM diagnoses associated with mental-health-related VASRD disability codes. The most common diagnoses, as a group, are those related to affective psychoses. At least 21% of all mental health disability may be attributable to affective psychoses (ICD-9-CM diagnoses 296.2, 296.3, 296.4, 296.6). This is followed, in frequency, by adjustment reactions and hysteria, 7.39% and 4.98%, respectively.

Table 8e. The 10 most common ICD-9-CM primary diagnoses associated with Mental Disorder VASRD Group, 1984-1999.

ICD-9-CM code (number and title)	Frequency	Percent of total*
309.8 Other Specified Adjustment Reactions	43	7.39%
296.4 Bipolar Affective Disorder, Manic	39	6.70%
296.2 Major Depressive Disorder Single Episode	38	6.53%
296.3 Major Depressive Disorder, Recurrent Episode	30	5.15%
300.1 Hysteria	29	4.98%
295.3 Paranoid Schizophrenia	22	3.78%
310.2 Post-concussion Syndrome	19	3.26%
781.9 Nervous/Musculoskeletal System, NEC	17	2.92%
211 Depressive Disorder, NEC	16	2.75%
296.6 Bipolar Affective Disorder, Mixed	15	2.58%

* Percents are given out of the total number of mental disorder disability cases with a disability-related CRO hospital record (N=582).

Table 8f shows the ICD-9-CM clinical diagnoses most commonly associated with endocrine system disability discharges. Diabetes is the most commonly diagnosed endocrine disorder with diabetes mellitus, without complication, describing over half of all endocrine disability (57%). The combination of diabetes mellitus without complication, with unspecified complication, with ketoacidosis, with ophthalmic, neurological, renal or other manifestations, and with peripheral circulatory disorders together explain or describe 87% of the most common endocrine disorder disability cases.

Table 8f. The 10 most common ICD-9-CM primary diagnoses associated with Endocrine System VASRD Group, 1984-1999.

ICD-9-CM code (number and title)	Frequency	Percent of total
250.0 Diabetes Mellitus w/o Mention of Complication	313	57.12%
250.9 Diabetes with Unspecified Complication	92	16.79%
250.1 Diabetes with Ketoacidosis	23	4.20%
250.6 Diabetes with Neurological Manifestations	16	2.92%
250.5 Diabetes with Ophthalmic Manifestations	13	2.37%
250.8 Diabetes with Other Specified Manifestations	9	1.64%
255.4 Corticoadrenal Insufficiency	8	1.46%
250.7 Diabetes with Peripheral Circulatory Disorders	6	1.09%
992.0 Heat Stroke and Sunstroke	5	0.91%
250.4 Diabetes with Renal Manifestations	4	0.73%

* Percents are given out of the total number of endocrine system disability cases with a disability-related CRO hospital record (N=548).

Table 8g displays ICD-9-CM codes associated with digestive system disability codes. The most common clinical diagnosis associated with a digestive system disability discharge code is regional enteritis. Regional and ulcerative enteritis (555.9 and 555.0, respectively) comprised nearly 17% of the most common digestive system disability clinical diagnoses.

Table 8g. The 10 most common ICD-9-CM primary diagnoses associated with Digestive System VASRD Group, 1984-1999.

ICD-9-CM code (number and title)	Frequency	Percent of total*
555.9 Regional Enteritis, Unspecified Site	59	13.53%
789.0 Abdominal Pain	28	6.42%
556 Ulcerative Colitis	26	5.96%
625.9 Unspecified Symptom Associated with Female Genital Organs	24	5.50%
564.1 Irritable Bowel Syndrome	18	4.13%
571.4 Chronic Hepatitis	18	4.13%
555.0 Regional Enteritis, Small Intestine	14	3.21%
556.0 Ulcerative (Chronic) Enterocolitis	13	2.98%
577.1 Chronic Pancreatitis	12	2.75%
530.1 Esophagitis	11	2.52%

* Percents are given out of the total number of digestive system disability cases with a disability-related CRO hospital record (N=436).

Table 8h describes clinical diagnoses associated with eye-related disability. The particular disorders that may result in eye disability vary substantially, though all of the top ten fall within the ICD-9-CM list of disorders of the eye and adnexa (360-379), rather than eye-related injury (ICD-9-CM codes 870-871.9) or other possible eye-related clinical diagnoses.

Table 8h. The 10 most common ICD-9-CM primary diagnoses associated with Eye VASRD Group, 1984-1999.

ICD-9-CM code (number and title)	Frequency	Percent of total*
362.7 Hereditary Retinal Dystrophies	30	8.57%
360.8 Other Disorders of the Globe	21	6.00%
368.2 Diplopia	18	5.14%
369.6 Profound Impairment, One Eye	17	4.86%
379.3 Aphakia and Other Disorders of Lens	17	4.86%
365.1 Open-angle Glaucoma	15	4.29%
361.0 Retinal Detachment with Retinal Defect	11	3.14%
369.7 Moderate or Severe Impairment, One Eye	11	3.14%
368.0 Amblyopia ex Anopsia	10	2.86%
377.3 Optic Neuritis	10	2.86%

* Percents are given out of the total number of eye disability cases with a disability-related CRO hospital record (N=350).

Scar conditions and fibrosis of the skin (Table 8i) was the most common ICD-9-CM clinical finding among Soldiers discharged with a skin disorder disability (709.2, 13.45%). Five of the top ten ICD-9-CM diagnoses were from the "other inflammatory conditions of skin and subcutaneous tissue" (690-698) portion of the ICD-9-CM codebook. These five conditions (other atopic dermatitis and related conditions, contact dermatitis and other eczema unspecified, other psoriasis, dermatitis due to solar radiation, and dermatitis due to chemical products) were associated with 24% of the most common skin disorder disability cases.

Table 8i. The 10 most common ICD-9-CM primary diagnoses associated with Skin VASRD Group, 1984-1999.

ICD-9-CM code (number and title)	Frequency	Percent of total*
709.2 Scar Conditions and Fibrosis of Skin	48	13.45%
691.8 Other Atopic Dermatitis and Related Conditions	25	7.00%
692.9 Contact Dermatitis and Other Eczema, Unspecified	25	7.00%
696.1 Other Psoriasis	17	4.76%
705.8 Other Specified Disorders of Sweat Glands	14	3.92%
757.3 Other Specified Anomalies of Skin	11	3.08%
692.7 Dermatitis due to Solar Radiation	10	2.80%
692.4 Dermatitis due to Other Chemical Products	9	2.52%
701.4 Keloid Scar	9	2.52%
701.1 Keratoderma, Acquired	8	2.24%

* Percents are given out of the total number of skin disability cases with a disability-related CRO hospital record (N=357).

Table 8j describes the ICD-9-CM clinical diagnoses associated with infectious diseases, immune, and nutritional disability codes. HIV infection was the single most common ICD-9-CM diagnosis associated with this broad VASRD group. In contrast to HIV, an infectious disease, the second, third, and fifth most common diagnoses (systemic lupus erythematosus [13%], unspecified myalgia and myositis, and Systemic sclerosis) all fall within the diseases of the musculoskeletal system and connective tissue (710-739) portion of the ICD-9-CM codebook. The fourth and sixth most common diagnoses for this VASRD group are also within the infectious disease ICD-9-CM category.

Table 8j. The 10 most common ICD-9-CM primary diagnoses associated with Infectious Disease, Immune Disorder, Nutritional Deficiency VASRD Group, 1984-1999.

ICD-9-CM code (number and title)	Frequency	Percent of total*
042 Human Immunodeficiency Virus	31	21.83%
710.0 Systemic Lupus Erythematosus	19	13.38%
729.1 Myalgia and Myositis, Unspecified	12	8.45%
135 Sarcoidosis	9	6.34
710.1 Systemic Sclerosis	6	4.23%
112.0 Candidiasis of Mouth	5	3.52%
780.7 Malaise and Fatigue	5	3.52%
443.0 Raynaud's Syndrome	3	2.11%
756.8 Other specified anomalies of muscle, tendon, fascia, and connective tissue	3	2.11%
785.6 Enlargement of Lymph Nodes	3	2.11%

* Percents are given out of the total number of infectious disease, immune disorder, nutritional deficiency disability cases with a disability-related CRO hospital record (N=142).

Table 8k describes the most common ICD-9-CM diagnoses associated with genitourinary disorder VASRD codes. Hypertensive renal disease (unspecified) and unspecified disorder of male genital organs were the most common single diagnoses, associated with 9% of the top genitourinary disabilities. Four out of the top ten diagnoses were from the 580-589 ICD-9-CM group, nephritis, nephritic syndrome and nephrosis, within the diseases of the genitourinary system. These four ICD-9-CM diagnoses were associated with 18% of all genitourinary disability.

Table 8k. The 10 most common ICD-9-CM primary diagnoses associated with Genitourinary System VASRD Group, 1984-1999.

ICD-9-CM code (number and title)	Frequency	Percent of total*
403.9 Hypertensive Renal Disease, Unspecified	16	8.94%
608.9 Unspecified Disorder of Male Genital Organs	16	8.94%
583.9 Nephritis and nephropathy, with Unspecified Pathological Lesion in Kidney	15	8.38%
604.9 Other Orchitis, Epididymitis, and Epididymo-Orchitis, w/o Mention of Abscess	11	6.15%
753.1 Cystic Kidney Disease	11	6.15%
582.1 Chronic Glomerulonephritis, with Lesion of Membranous Glomerulonephritis	9	5.03%
599.7 Hematuria	7	3.91%
189.0 Malignant Neoplasm of Kidney, Except Pelvis	6	3.35%
583.8 Nephritis and Nephropathy, with Other Specified Pathological Lesion in Kidney	5	2.79%
581.1 Nephrotic Syndrome, with Lesion of Membranous Glomerulonephriti	4	2.23%

* Percents are given out of the total number of genitourinary system disability cases with a disability-related CRO hospital record (N=179).

Table 8l describes clinical diagnoses associated with disability codes related to diseases of the ear and other sense organs (excluding eye – Table 8h). Sensorineural hearing loss is by far the most common diagnoses associated with these disabilities. With the exception of the sixth most common diagnoses, all the diagnoses are from diseases of the nervous system and sensory organs, specifically diseases of the ear and mastoid process (ICD-9-CM 380-389). About 4% of the top ten causes of ear and sensory organ disability have a clinical diagnoses of 780.4 (dizziness and giddiness, not associated with ménière's disease) from the "Symptoms, Signs and Ill-Defined Conditions" portion of the ICD-9-CM index. Four of the top ten are codes related to hearing loss (389), and three are codes from ICD-9-CM 386, "Vertiginous syndromes and other disorders of vestibular system."

Table 8l. The 10 most common ICD-9-CM primary diagnoses associated with Ear and other sense organs VASRD Group, 1984-1999.

ICD-9-CM code (number and title)	Frequency	Percent of total*
389.1 Sensorineural Hearing Loss	110	47.01%
389.8 Other Specified Forms of Hearing Loss	19	8.12%
389.9 Unspecified Hearing Loss	19	8.12%
386.0 Meniere's Disease	17	7.29%
389.2 Mixed Conductive and Sensorineural Hearing Loss	11	4.70%
780.4 Dizziness and Giddiness	9	3.85%
386.1 Other and Unspecified Peripheral Vertigo	7	2.99%
388.3 Tinnittus	6	2.56%
386.5 Labyrinthine Dysfunction	4	1.71%
388.1 Noise Effects on Inner Ear	4	1.71%

* Percents are given out of the total number of ear and other sense organ disability cases with a disability-related CRO hospital record (N=234).

Sickle-cell anemia was the most common diagnoses associated with disability codes for diseases of the hemic and lymphatic system (Table 8m). Five of the top ten diagnoses, including sickle-cell anemia, fall within the diseases of the blood and blood-forming organs (280-289) ICD-9-CM diagnostic group. These five clinical diagnoses describe 39% of the top disability related to diseases of the hemic and lymphatic system. Four of the top ten diagnoses fall into malignant neoplasms of lymphatic and hematopoietic tissue (200-208) comprising 14% of all hemic and lymphatic-related diagnoses. This VASRD group, like the infectious, immune, and nutritional disorder disability codes, is quite heterogeneous.

Table 8m. The 10 most common ICD-9-CM primary diagnoses associated with Hemic and Lymphatic Systems VASRD Group, 1984-1999.

ICD-9-CM code (number and title)	Frequency	Percent of total*
282.6 Sickle-Cell Anemia	14	16.87%
282.4 Thalassemias	6	7.23%
286.4 von Willebrand's Disease	6	7.23%
204.0 Acute Lymphoid Leukemia	4	4.82%
205.1 Chronic Myeloid Leukemia	4	4.82%
728.8 Other Disorders of Muscle, Ligament, and Fascia	4	4.82%
286.0 Congenital factor VIII disorder	3	3.61%
287.3 Primary Thrombocytopenia	3	3.61%
200.1 Lymphosarcoma	2	2.41%
201.9 Hodgkins Disease, Unspecified	2	2.41%

* Percents are given out of the total number of hemic and lymphatic systems disability cases with a disability-related CRO hospital record (N=83).

Table 8n displays the most common clinical diagnosis associated with gynecological and breast disability. One-quarter of the top gynecological and breast disability falls within the 625.9 ICD diagnostic group, "unspecified symptom associated with female genital organs." Typically this refers to pain in the broad ligament, the perineum, ovary, round ligament, uterus, vagina, or vulva (1 142).

Table 8n. The 10 most common ICD-9-CM primary diagnoses associated with Gynecological Conditions and Breast Disorders VASRD Group, 1984-1999.

ICD-9-CM code (number and title)	Frequency	Percent of total*
625.9 Unspecified Symptom Associated with Female Genital Organs	9	25.71%
617.9 Endometriosis, Site Unspecified	6	17.14%
789.0 Abdominal Pain	4	11.43%
614.6 Pelvic Peritoneal Adhesions, Female	3	8.57%
174.9 Malignant Neoplasm of Breast, Unspecified	2	5.71%
611.7 Signs and Symptoms in Breast	2	5.71%
256.4 Polycystic Ovaries	1	2.86%
427.6 Premature Beats	1	2.86%
616.0 Cervicitis	1	2.86%
617.3 Endometriosis of Pelvic Peritoneum	1	2.86%

* Percents are given out of the total number of gynecological conditions and breast disorder disability cases with a disability-related CRO hospital record (N=35).

Temporomandibular joint disorder is the most frequent clinical diagnosis associated with a dental or oral disability. Very low frequency of dental- and oral-related disability cases makes it difficult to draw many conclusions about the link between ICD-9-CM codes and these types of disability (Table 8o).

Table 8o. The 10 most common ICD-9-CM primary diagnoses associated with Dental and Oral Conditions VASRD Group, 1984-1999.

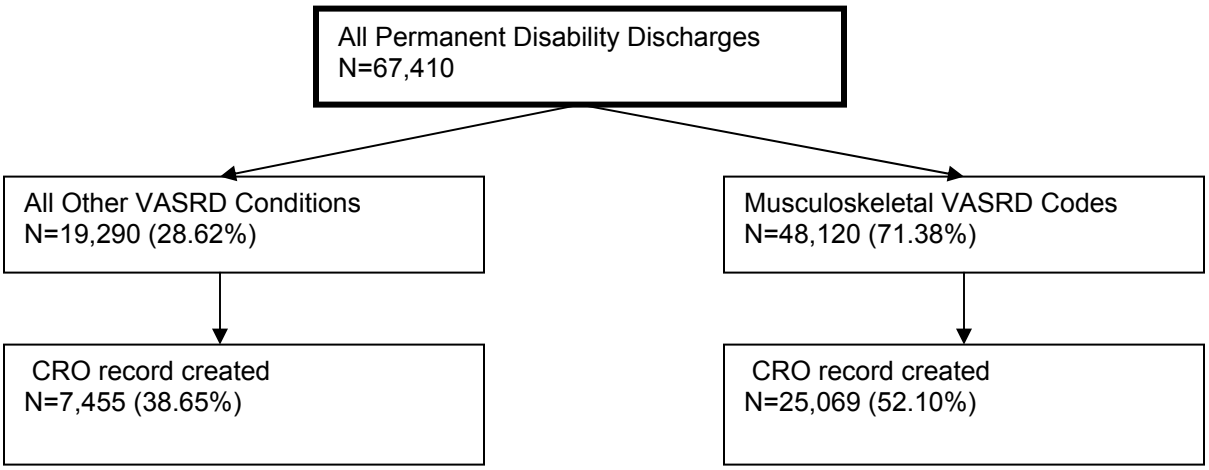
ICD-9-CM code (number and title)	Frequency	Percent of total*
524.6 Temporomandibular Joint Disorder	9	75.00%
524.3 Anomalies of Tooth Position	1	8.33%
715.9 Osteoarthrosis, Unspecified	1	8.33%
728.9 Unspecified Disorder of Muscle, Ligament, and Fascia	1	8.33%

* Percents are given out of the total number of dental and oral disability cases with a disability-related CRO hospital record (N=12).

PART III. FOCUSING ON MUSCULOSKELETAL CONDITIONS

Musculoskeletal disabilities far outnumber other disabilities. 71.4% of all disability conditions among all Soldiers discharged with a permanent disability fall within the musculoskeletal VASRD category (Figure 2). As described in more detail in section I of the results in this report, over half of all musculoskeletal disability cases have a corresponding CRO record. The remainder of this section focuses exclusively on those 25,069 permanent disability cases with both a primary VASRD code of musculoskeletal disability and a linked CRO hospital record.

Figure 2. Musculoskeletal VASRD cases versus all other VASRD cases and available disability-related CRO hospital records, 1984-1999



Because musculoskeletal conditions comprise such a large portion of the total disability population, this section of the report focuses exclusively on this large and rapidly growing group by drilling down to the specific VASRD subcategories of musculoskeletal conditions. These categories become quite numerous and, in some cases, some of the categories are rarely used, so only the most frequently used (populated) categories and subcategories are analyzed.

Musculoskeletal conditions are initially grouped or broken down into one of three categories: Injury, Disease, or Amputation/Prosthetics. An additional small portion (0.3%) of musculoskeletal conditions lack enough detail to place it in one of these subcategories and are thus placed in the "missing" subgroup (Figure 3).

"Injury" is the largest group comprising over 56% of the musculoskeletal disability, followed by Diseases which make up about 43% of cases. Amputation or prosthetics make up a very small portion (0.7%) of musculoskeletal disability and thus are not a focal point for the remaining analyses to investigate ICD-9-CM patterns.

Figure 3. Categories of Musculoskeletal VASRD and available disability-related hospital records, 1984-1999

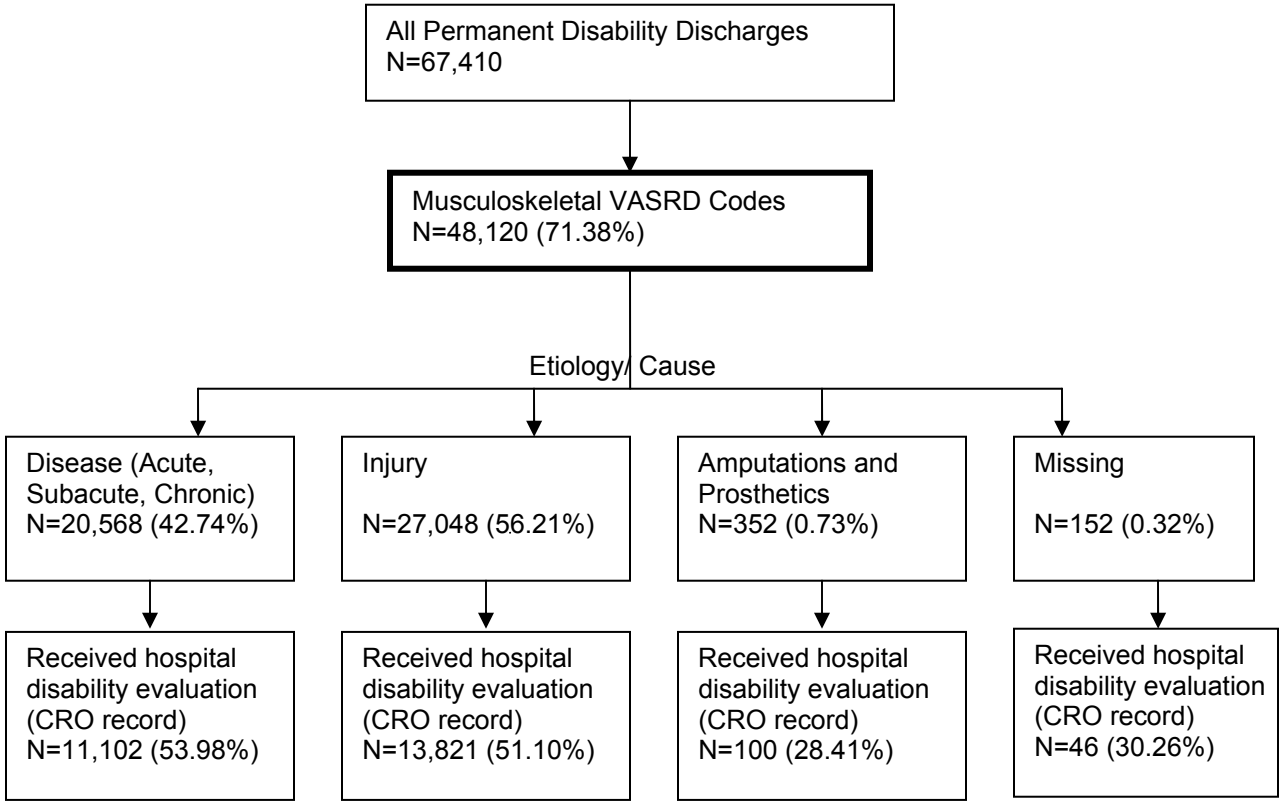


Figure 4 focuses on the largest of the musculoskeletal subgroups – "Injury." "Injury" is further subdivided into either "skeletal" or "muscular" subordinate VASRD groups, with the vast majority of "Injury" disability (97%) falling within the "skeletal" category.

Figure 4. Categories of Musculoskeletal Injury VASRD cases, Muscle versus Skeletal and available disability-related hospital records, 1984-1999

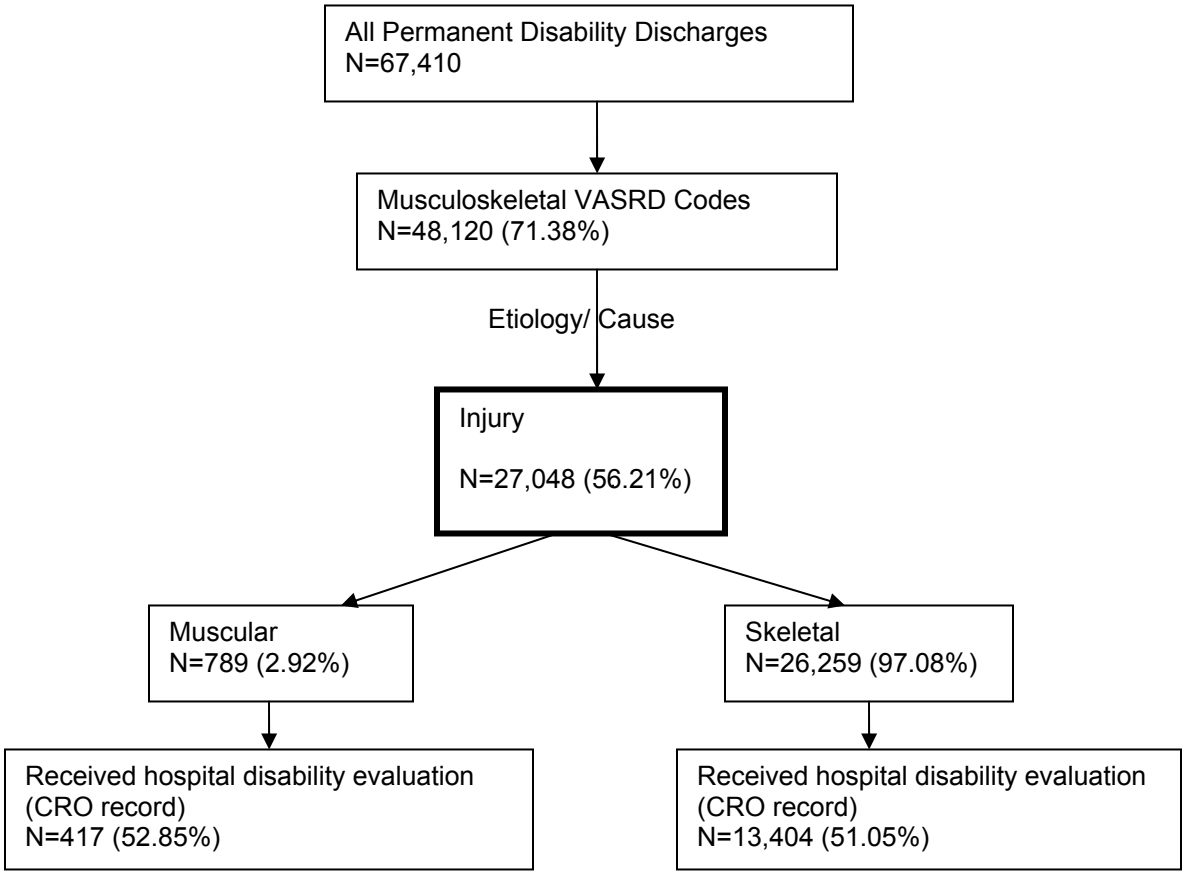


Figure 5 divides the "skeletal" subcategory of the "Injury" group into even smaller subgroups that reflect the body region affected by the condition. Back-related "skeletal Injury" (N=12,911) is the largest category of musculoskeletal disability, comprising 49% of the "skeletal Injury" and almost 27% of all musculoskeletal disability. This is followed by "skeletal Injury" involving the leg, which comprises 43% of all "skeletal Injury" and 23% of the total musculoskeletal disability group.

Figure 5. Subcategories of Musculoskeletal Injury-Skeletal VASRD cases and available disability-related hospital records, 1984-1999

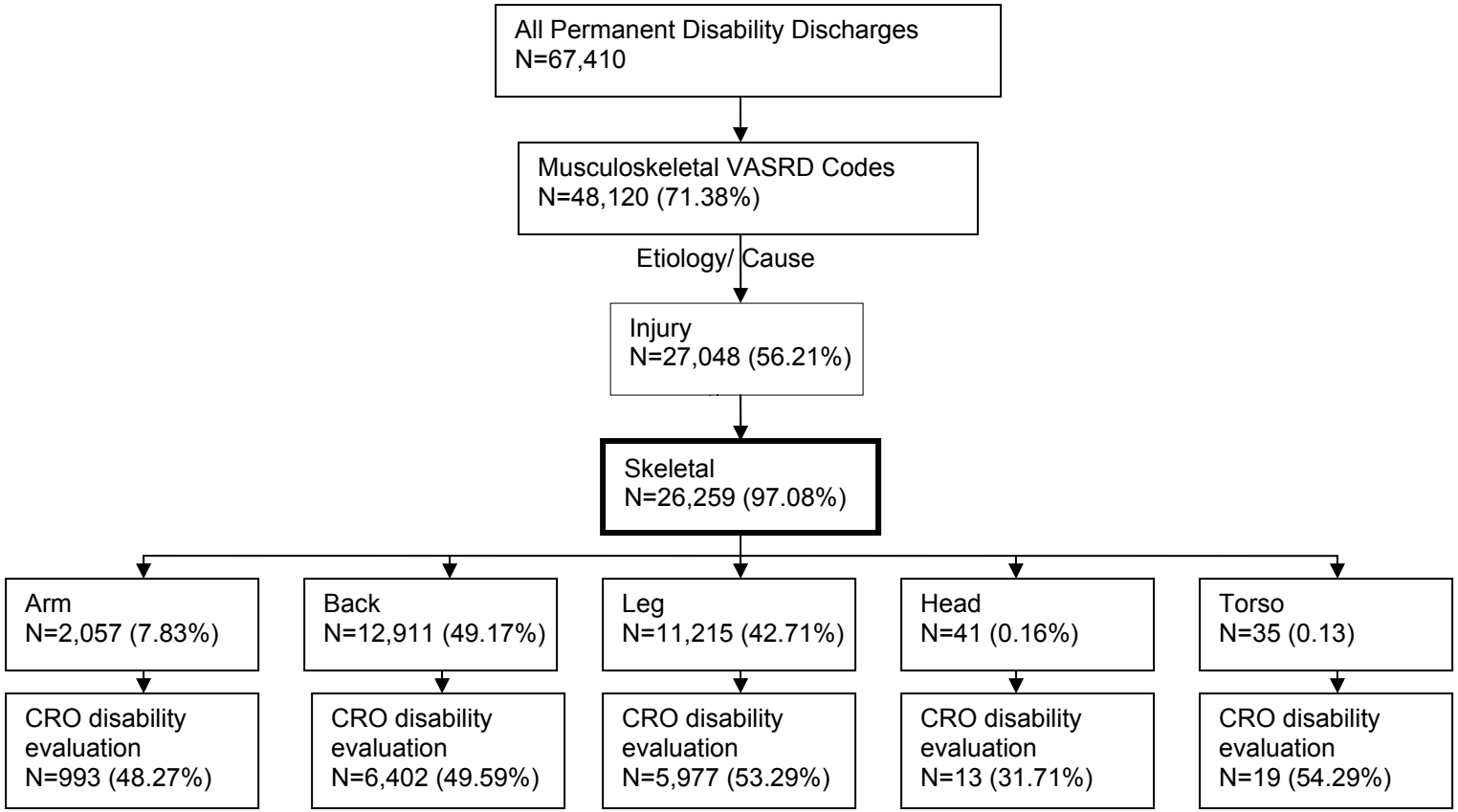
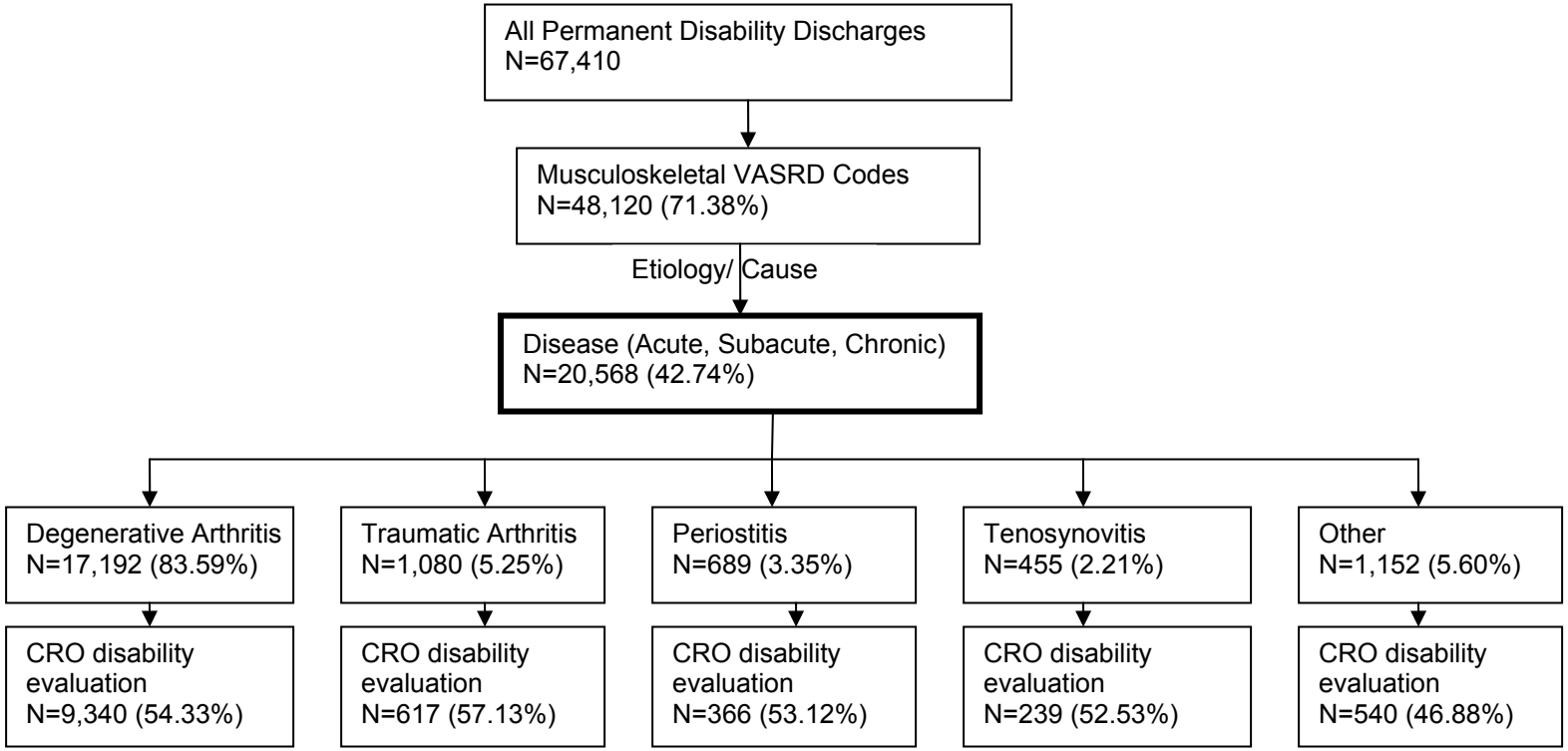


Figure 6 displays musculoskeletal “Disease” disorders, which include arthritis (degenerative and traumatic) and periostitis and tenosynovitis. Degenerative arthritis followed by traumatic arthritis comprise the largest proportion of codes.

Figure 6. Subcategories of Musculoskeletal Disease VASRD cases and available disability-related hospital records, 1984-1999



PROPORTION OF MUSCULOSKELETAL CASES BY SUBCATEGORIES

A. ICD-9-CM diagnoses most frequently associated with the most common specific codes under musculoskeletal conditions

1. ICD-9-CM Conditions Associated with the Major Musculoskeletal Disability Subgroups

The most frequent ICD-9-CM diagnoses associated with a musculoskeletal condition subgrouped as “Injury” include lumbago (22.4%), joint pain (8.9%), and joint derangement (6%). The most frequent ICD-9-CM diagnoses associated with a musculoskeletal condition subgrouped as “Disease” include joint pain (28.3%), chondromalacia of patella (6.8%), and osteoarthrosis (5.3%). Both “Injury” and “Disease” subgroups of musculoskeletal conditions have associated ICD-9-CM diagnoses in the 710-739 range (Diseases of the musculoskeletal system and connective tissue). Thus, the VASRD subgrouping of “Injury” versus “Disease” within the musculoskeletal conditions VASRD group may be somewhat arbitrary, at least with regard to clinical significance. Nearly half of musculoskeletal “Injury” common diagnoses comprised lumbago, pain in joint, pain in limb, osteoarthrosis, other joint disorders and knee-related conditions (total=44.9% for injuries), and 58.3% of musculoskeletal “Disease” were comprised of those conditions (Table 9).

Table 9. 10 most common ICD-9-CM diagnoses within each subgroup of Musculoskeletal VASRD Conditions.

Categories of Musculoskeletal Conditions (N=93,958)	10 Most Common ICD-9-CM Diagnoses	Frequency and Percent
Injury (N=27,048; 13,821 with disability-related hospital record)	724.2 Lumbago	3,090 (22.36%)
	719.4 Pain in Joint	1,220 (8.83%)
	718.8 Joint Derangement, Not Elsewhere Classified	830 (6.01%)
	722.1 Displacement of Thoracic or Lumbar Intervertebral Disc w/o Myelopathy	593 (4.29%)
	734 Flat Foot	577 (4.17%)
	717.8 Other Internal Derangement of Knee	526 (3.81%)
	729.5 Pain in Limb	292 (2.11%)
	722.5 Degeneration of Thoracic or Lumbar Intervertebral Disc	264 (1.91%)
	715.9 Osteoarthrosis, Unspecified	250 (1.81%)
	756.1 Anomalies of Spine	246 (1.78%)

Disease (N=20,568; 11,102 with disability-related hospital record)	719.4 Pain in Joint	3,144 (28.32%)
	717.7 Chondromalacia of Patella	753 (6.78%)
	715.9 Osteoarthrosis, Unspecified	591 (5.32%)
	716.1 Traumatic Artropathy	526 (4.74%)
	729.5 Pain in Limb	460 (4.14%)
	715.3 Local Osteoarthritis, Unspecified	360 (3.24%)
	733.1 Pathological Fracture	354 (3.19%)
	719.8 Other Specified Disorders of the Joint	319 (2.87%)
	724.2 Lumbago	263 (2.37%)
	733.9 Other and Unspecified Disorders of Bone and Cartilage	258 (2.32%)
Amputation/ Prosthetics (N=352; 100 with disability-related hospital record)	736.2 Other Acquired Deformities of Finger	15 (15.00%)
	736.8 Acquired Deformities of Other Parts of Limbs	11 (11.00%)
	729.5 Pain in Limb	10 (10.00%)
	719.4 Pain in Joint	9 (9.00%)
	715.9 Osteoarthrosis, Unspecified	3 (3.00%)
	735.8 Other Acquired Deformities of Toe	3 (3.00%)
	736.7 Other Acquired Deformities of Ankle and Foot	3 (3.00%)
	354.9 Mononeuritis of Upper Limb, Unspecified	2 (2.00%)
	718.4 Contracture of Joint	2 (2.00%)
	727.6 Rupture of Tendon, Nontraumatic	2 (2.00%)
Missing/Unknown (N=152; 46 with disability-related hospital record)	719.4 Pain in Joint	5 (10.87%)
	724.2 Lumbago	5 (10.87%)
	344.0 Quadriplegia and Quadriparesis	3 (6.52%)
	717.7 Chondromalacia of Patella	3 (6.52%)
	715.3 Local Osteoarthritis, Unspecified	2 (4.35%)
	719.8 Other Specified Disorders of the Joint	2 (4.35%)
	728.8 Other Disorders of Muscle, Ligament, and Fascia	2 (4.35%)
	736.8 Acquired Deformities of Other Parts of Limbs	2 (4.35%)
	335.2 Motor Neuron Disease	1 (2.17%)
	344.1 Paraplegia	1 (2.17%)

2. Injury: Muscle or Skeletal

Musculoskeletal disabilities from the "Injury" subgroup are divided into either "skeletal" or "muscular" conditions, with the vast majority (97.1%) falling in the "skeletal" category. The most common ICD-9-CM diagnoses associated with a "skeletal injury" VASRD disability include lumbago, joint pain, and joint derangement. The most common diagnoses among those with a "muscular" condition include fibromatoses, joint pain, and other disorders of muscle, ligament, and fascia. Joint pain appears to be common to many or most of the musculoskeletal disability cases.

When comparing the most common ICD diagnoses between Soldiers who eventually receive a "muscular-related" injury musculoskeletal disability with those who receive a "skeletal-related" injury musculoskeletal disability, the majority of diagnoses in the "skeletal" group (23%) were for lumbago, while 27.1% of the "muscular" group was diagnosed with fibromatoses. Pain in joint and pain in limb were common among both groups. The "muscular" disability group had more muscle-disorder-related hospitalizations, while the "skeletal" group, by far the more common VASRD subgroup, had more back- and knee-related hospitalizations (Table 10).

Table 10. 10 most common ICD-9-CM diagnoses within each subgroup of Injury (within the Musculoskeletal Conditions broad VASRD group).

Categories of Musculoskeletal Injury Conditions (N=27,048; 13,821 with a disability-related hospital record)	10 Most Common ICD-9-CM Diagnoses	Frequency and Percent
Skeletal (N=26,259; 13,404 with disability-related hospital record)	724.2 Lumbago	3,088 (23.04%)
	719.4 Pain in Joint	1,189 (8.87%)
	718.8 Joint Derangement, Not Elsewhere Classified	825 (6.15%)
	722.1 Displacement of Thoracic or Lumbar Intervertebral Disc w/o Myelopathy	593 (4.42%)
	717.8 Other Internal Derangement of the Knee	526 (3.92%)
	734 Flat Foot	405 (3.02%)
	722.5 Degeneration of Thoracic or Lumbar Intervertebral Disc	264 (1.97)
	729.5 Pain In Limb	264 (1.97%)
	715.9 Osteoarthrosis, Unspecified	249 (1.86%)
	756.1 Anomalies of Spine	246 (1.84%)

Muscular (N=789; 417 with disability-related hospital record)	728.7 Other Fibromatoses	113 (27.10%)
	719.4 Pain in Joint	31 (7.43%)
	728.8 Other Disorders of Muscle, Ligament, and Fascia	31 (7.43%)
	729.5 Pain in Limb	28 (6.71%)
	729.1 Myalgia and Myositis, Unspecified	13 (3.12%)
	728.9 Unspecified Disorder of Muscle, Ligament, and Fascia	13 (3.12%)
	726.7 Enthesopathy of Ankle and Tarsus	11 (2.64%)
	789.0 Abdominal Pain	11 (2.64%)
	734 Flat Foot	9 (2.16%)
	723.1 Cervicalgia	8 (1.92%)

Injury Subgroups: Skeletal. Because the "Skeletal" category comprises 96% of all the musculoskeletal "Injury" conditions, Table 11 focuses just on skeletal injuries. The "Skeletal" category (N=26,259) breaks down disabilities into the following five anatomically derived subgroups: "Arm" (N=2,057, 8%), "Back" (N=12,911, 49%), "Leg" (N=11,215, 43%), "Head" (N=41, 0.2%), "Torso" (N=35, 0.1%). Fifty percent (N=6,402) of those with "back", 53% (N=5,977) of those with "leg," and 48% (N=933) of those with "arm" permanent skeletal disabilities have an associated CRO hospitalization.

Back disabilities comprised 49% of all "Skeletal" disabilities, with ICD-9-CM diagnoses appropriately all falling within the back-related diagnostic group. Anomalies of the spine, a congenital defect, was the only condition in the top ten list that did not fall within the "Diseases of the musculoskeletal system and connective tissue" broad ICD-9-CM group. Leg disabilities were the next largest subgroup of "Skeletal" disability comprising 43%. Approximately 23% of Soldiers with leg-related and a disability-related hospital record had a leg-related diagnosis, but the rest were unspecified conditions. Back- and knee-related disabilities should receive greater study.

Table 11. 10 most common ICD-9-CM diagnoses within each subgroup of Skeletal Injury (within the Musculoskeletal Conditions broad VASRD group).

Categories of Musculoskeletal Skeletal Injury Conditions (N=26,259; 13,404 with a disability-related hospital record)	10 Most Common ICD-9-CM Diagnoses	Frequency and Percent
Back (N=12,911; 6,402 with disability-related hospital record)	724.2 Lumbago	3,063 (47.84%)
	722.1 Displacement of Thoracic or Lumbar Intervertebral Disc w/o Myelopathy	590 (9.22%)
	722.5 Degeneration of Thoracic or Lumbar Intervertebral Disc	264 (4.12%)
	756.1 Anomalies of Spine	245 (3.83%)
	738.4 Acquired Spondylolisthesis	235 (3.67%)
	724.5 Backache, Unspecified	171 (2.67%)
	724.6 Disorders of Sacrum	155 (2.42%)
	7244 Thoracic or Lumbosacral Neuritis or Radiculitis, Unspecified	140 (2.19%)
	722.2 Displacement of Intervertebral Disc, Site Unspecified, w/o Myelopathy	112 (1.75%)
	721.3 Lumbosacral Spondylosis, w/o Myelopathy	96 (1.50%)
Leg (N=11,215; 5,977 with disability-related hospital record)	719.4 Pain in Joint	955 (15.98%)
	718.8 Joint Derangement, Not Elsewhere Classified	662 (11.08%)
	734 Flat Foot	560 (9.37%)
	717.8 Other Internal Derangement of the Knee	523 (8.75%)
	729.5 Pain in Limb	239 (4.00%)
	715.9 Osteoarthrosis, Unspecified	181 (3.03%)
	717.7 Chondromalacia of Patella	153 (2.56%)
	736.7 Other Acquired Deformities of Ankle and Foot	151 (2.53%)
	733.1 Pathological Fracture	148 (2.48%)
	716.1 Traumatic Arthropathy	146 (2.44%)

Arm (N=2,057; 993 with disability-related hospital record)	719.4 Pain in Joint	189 (19.03%)
	718.3 Recurrent Dislocation	155 (15.61%)
	718.8 Joint Derangement, Not Elsewhere Classified	154 (15.51%)
	733.8 Malunion and Nonunion of Fracture	82 (8.26%)
	719.5 Stiffness of Joint, Not Elsewhere Classified	49 (4.93%)
	718.5 Ankylosis of Joint	47 (4.73%)
	726.2 Other Affections of Shoulder Region, Not Elsewhere Classified	41 (4.13%)
	716.1 Traumatic Arthropathy	29 (2.92%)
	715.9 Osteoarthrosis, Unspecified	24 (2.42%)
	729.5 Pain in Limb	16 (1.61%)
Head (N=41; 13 with disability-related hospital record)	724.2 Lumbago	3 (23.08%)
	345.9 Epilepsy, Unspecified	2 (15.38%)
	310.2 Post-concussion Syndrome	1 (7.69%)
	352.9 Unspecified Disorder of Cranial Nerves	1 (7.69%)
	360.8 Other Disorders of Globe	1 (7.69%)
	719.4 Pain in Joint	1 (7.69%)
	734 Flat Foot	1 (7.69%)
	737.3 Kyphoscoliosis and Scoliosis	1 (7.69%)
	738.1 Other Acquired Deformity of the Head	1 (7.69%)
	754.0 Congenital Musculoskeletal Deformities of Skull, Face and Jaw	1 (7.69%)
Torso (N=35; 19 with disability-related hospital record)	733.6 Tietze's Disease	5 (26.32%)
	786.5 Chest Pain	3 (15.79%)
	730.9 Unspecified Infection of Bone	2 (10.53%)
	344.8 Other Specified Paralytic Syndromes	1 (5.26%)
	389.1 Sensorineural Hearing Loss	1 (5.26%)
	701.1 Keratoderma, Acquired	1 (5.26%)
	717.8 Other Internal Derangement of the Knee	1 (5.26%)
	719.4 Pain in Joint	1 (5.26%)
	719.8 Other Specified Disorders of the Joint	1 (5.26%)
	733.2 Cyst of Bone	1 (5.26%)

3. Disease

Investigation of "Disease," the second most common major subcategory of the VASRD Musculoskeletal Conditions following "Injury," reveals more details regarding the types of medical conditions contributing to this rapidly growing category of disability. The four most common conditions within the "Disease" group of musculoskeletal disability comprise over 94% of all musculoskeletal "Disease" disability and include degenerative arthritis, traumatic arthritis, periostitis, and tenosynovitis with degenerative arthritis, followed by traumatic arthritis comprising the largest of these groups (Table 12). For degenerative arthritis the most common specific diagnosis was pain in joint, while the most common diagnosis for traumatic arthritis was traumatic arthropathy. Lumbago (low back pain) was the eighth most common diagnosis among those with a degenerative arthritis disability. The other three categories of musculoskeletal disease disability seem to more often involve disability of the knee or limbs. Of those discharged with a Periostitis disability, only 6% of those with a disability-related hospitalization had an ICD diagnosis for periostitis. More often they were diagnosed with pathological fractures, unspecified disorders of bone and cartilage, and unspecified pain in the joint or limb.

Table 12. 10 most common ICD-9-CM diagnoses within each subgroup of Disease (within the Musculoskeletal Conditions broad VASRD group).

Categories of Musculoskeletal Disease Conditions (N=20,568; 11,102 with disability-related hospital record)	10 Most Common ICD-9-CM Diagnoses	Frequency and Percent
Degenerative Arthritis (N=17,192; 9,340 with disability-related hospital record)	719.4 Pain in Joint	2,394 (31.41%)
	717.7 Chondromalacia of Patella	708 (7.58%)
	715.9 Osteoarthrosis, Unspecified	513 (5.49%)
	729.5 Pain In Limb	404 (4.33%)
	716.1 Traumatic Artropathy	333 (3.57%)
	715.3 Local Osteoarthritis, Unspecified	325 (3.48%)
	719.8 Other Specified Disorders of the Joint	311 (3.33%)
	724.2 Lumbago	245 (2.62%)
	733.1 Pathological Fracture	213 (2.28%)
	718.8 Joint Derangement, Not Elsewhere Classified	207 (2.02%)

Traumatic Arthritis (N=1,080; 617 with disability-related hospital record)	716.1 Traumatic Arthropathy	190 (30.79%)
	719.4 Pain in Joint	81 (13.13%)
	715.9 Osteoarthrosis, Unspecified	73 (11.83%)
	716.9 Arthropathy, Unspecified	34 (5.51%)
	717.7 Chondromalacia of Patella	33 (5.35%)
	715.3 Local Osteoarthritis, Unspecified	32 (5.19%)
	715.2 Osteoarthritis, Localized, Secondary	19 (3.08%)
	717.8 Other Internal Derangement of the Knee	13 (2.11%)
	733.8 Malunion and Nonunion of Fracture	9 (1.46%)
	732.7 Osteochondritis Dissecans	8 (1.30%)
Periostitis (N=689; 366 with disability-related hospital record)	733.1 Pathological Fracture	134 (36.61%)
	733.9 Other and Unspecified Disorders of Bone and Cartilage	76 (20.77%)
	729.5 Pain in Limb	41 (11.20%)
	719.4 Pain in Joint	30 (8.20%)
	733.3 Periostitis	22 (6.01%)
	736.8 Acquired Deformities of Other Parts of Limbs	7 (1.91%)
	844.9 Sprain or Strain, Unspecified Site of Knee and Leg	6 (1.64%)
	719.9 Unspecified Disorder of Joint	4 (1.09%)
	734 Flat Foot	4 (1.09%)
	719.8 Other Specified Disorders of the Joint	3 (0.82%)
Tenosynovitis (N=455; 239 with disability-related hospital record)	714.0 Pain in Joint	51 (21.34%)
	726.7 Enthesopathy of Ankle and Tarsus	43 (17.99%)
	726.6 Enthesopathy of Knee	29 (12.13%)
	727.0 Synovitis and Tenosynovitis	19 (7.95%)
	728.7 Other Fibromatoses	13 (5.44%)
	718.8 Joint Derangement, Not Elsewhere Classified	10 (4.19%)
	726.2 Other Affections of Shoulder Region, Not Elsewhere Classified	7 (2.93%)
	726.9 Unspecified Enthesopathy	7 (2.93%)
	718.3 Recurrent Dislocation	6 (2.51%)
	729.5 Pain in Limb	6 (2.51%)

Other (N=1,152; 540 with disability-related hospital record)	729.1 Myalgia and Myositis, Unspecified	79 (14.63%)
	719.4 Pain in Joint	48 (8.89%)
	726.5 Enthesopathy of Hip	44 (8.15%)
	714.0 Rheumatoid Arthritis	41 (7.59%)
	720.0 Ankylosing Spondylitis	31 (5.74%)
	099.3 Reiter's Disease	30 (5.56%)
	724.2 Lumbago	14 (2.59%)
	723.1 Cervicalgia	12 (2.22%)
	696.0 Psoriatic Arthropathy	10 (1.85%)
	728.8 Other Disorders of Muscle, Ligament, and Fascia	10 (1.85%)

PART IV: VARIATIONS IN VASRD AND ICD-9-CM CODING OF DISABILITIES OVER TIME

There have been temporal changes in the distribution of VASRD codes (Table 13). While the most common VASRD code has always been musculoskeletal conditions, the relative proportion of disability associated with musculoskeletal conditions has increased over time. Musculoskeletal conditions comprised 63% of disability cases from 1984-1989, 74% of cases in the early 1990s, and were up to nearly 79% from 1995 to 1999. Respiratory disability cases also increased as a percentage of total disability over time. Respiratory conditions comprised 3.8% of cases in the 1980s and increased too 4.4% of cases from 1995-1999. All other major VASRD categories decreased as a proportion of the total disability burden over time; most notably, mental health-related permanent disability discharges decreased from 4.9% of the total cases in the 1980s to 2.6% between 1995 and 1999; and cardiovascular disorders decreased from 8.7% between 1984 and 1989 to 2.2% of disability cases between 1995 and 1999. However, because mental health disability cases were least likely to have a corresponding CRO record, caution should be taken in comparisons of the relative proportions of cases by broad VASRD groups. It may be that increasing proportions of cases with CROs over the study period were predominantly occurring with in the musculoskeletal disability group and, thus, we have greater representation of those cases relative to mental health disorder and not necessarily smaller portions of mental health disability occurring over time.

Table 13. Proportion of disability cases by major VASRD group.

Category	Proportion of disability cases by era (% of VASRD Category over time) (% of total cases that era)		
	1984-1989	1990-1994	1995-1999
Musculoskeletal system (N=48,120)	15,441 (32.09%) (62.69%)	15,609 (32.44%) (73.85%)	17,070 (35.47%) (78.87%)
Mental disorders (N=2,615)	1,203 (46.00%) (4.88%)	856 (32.73%) (4.05%)	556 (21.26%) (2.57%)
Neurological conditions and convulsive disorders (N=4,180)	1,685 (40.31%) (6.84%)	1,332 (31.87%) (6.30%)	1,163 (27.82%) (5.37%)
Respiratory system (N=2,646)	933 (35.26%) (3.79%)	752 (28.42%) (3.56%)	961 (36.32%) (4.44%)
Cardiovascular system (N=3,271)	2,146 (65.61%) (8.71%)	667 (20.39%) (3.16%)	458 (14.00%) (2.12%)
Digestive system (N=1,143)	518 (45.32%) (2.10%)	344 (30.10%) (1.63%)	281 (24.58%) (1.30%)
Endocrine system (N=1,309)	697 (53.25%) (2.83%)	268 (20.47%) (1.27%)	344 (26.28%) (1.59%)
Infectious diseases, immune disorders, nutritional deficiencies (N=545)	274 (50.28%) (1.11%)	198 (36.33%) (0.94%)	73 (13.39%) (0.34%)
Eye (N=873)	481 (55.10%) (1.95%)	228 (26.12%) (1.08%)	164 (18.79%) (0.76%)
Skin (N=818)	409 (50.00%) (1.66%)	238 (29.10%) (1.13%)	171 (20.90%) (0.79%)
Genitourinary system (N=512)	261 (50.98%) (1.06%)	150 (29.30%) (0.71%)	101 (19.73%) (0.47%)
Ear and other sense organs (N=453)	237 (52.32%) (0.96%)	117 (25.83%) (0.55%)	99 (21.85%) (0.46%)
Hemic and Lymphatic Systems (N=302)	160 (52.98%) (0.65%)	82 (27.15%) (0.39%)	60 (19.87%) (0.28%)

Gynecological conditions and breast disorders (N=92)	34 (36.96%) (0.14%)	17 (18.48%) (0.08%)	41 (44.57%) (0.19%)
Dental and Oral Conditions (N=30)	16 (53.33%) (0.06%)	6 (20.00%) (0.03%)	8 (26.67%) (0.04%)
Missing (N=501)	137 (27.35 (0.56%)	272 (54.29%) (1.29%)	92 (18.36%) (0.43%)

Table 14 shows the top ten hospital diagnoses by era among Soldiers with a permanent disability discharge for all broad VASRD groups combined. Except for the introduction of asthma accounting for 3.2% of cases between 1995 and 1999, all of the most common ICD-9-CM diagnoses were musculoskeletal in nature and were consistently so throughout each era.

Table 14. Top 10 ICD-9-CM diagnoses by era—all VASRD groups.

Top 10 ICD-9-CM diagnoses					
1984-1989 N=9,514		**1990-1994 N-11,137**		**1995-1999 N=11,873**	
ICD-9-CM	N (%)	ICD-9-CM	N (%)	ICD-9-CM	N (%)
719.4 Pain in Joint	776 (8.16%)	719.4 Pain in Joint	1,478 (13.27%)	719.4 Pain in Joint	2,216 (18.66%)
724.2 Lumbago	677 (7.12%)	724.2 Lumbago	1,036 (9.30%)	724.2 Lumbago	1,692 (14.25%)
718.8 Joint Derangement, Not Elsewhere Classified	426 (4.48%)	715.9 Osteoarthrosis	375 (3.37%)	729.5 Pain in Limb	415 (3.50%)
717.7 Chondromalacia Patellae	354 (3.72%)	718.8 Joint Derangement, Not Elsewhere Classified	370 (3.32%)	493.9 Asthma, NOS	374 (3.15%)
716.1 Traumatic Artropathy	286 (3.01%)	717.7 Chondromalacia of Patella	322 (2.89%)	719.8 Other Specified Disorders of the Joint	308 (2.59%)
717.8 Other Internal Derangement of the Knee	224 (2.35%)	716.1 Traumatic Artropathy	309 (2.77%)	733.1 Pathological Fracture	282 (2.38%)
715.9 Osteoarthrosis	220 (2.31%)	717.8 Other Internal Derangement of the Knee	304 (2.73%)	718.8 Other Internal Derangement of the Knee	272 (2.29%)
734 Flat Foot	220 (2.31%)	729.2 Pain in Limb	249 (2.24%)	715.9 Osteoarthrosis	268 (2.26%)
729.5 Osteoarthrosis	219 (2.30%)	722.1 Displacement of Thoracic or Lumbar Intervertebral Disc w/o Myelopathy	224 (2.01%)	717.7 Chondromalacia of Patella	238 (2.00%)
715.3 Local Osteoarthritis, Unspecified	218 (2.29%)	734 Flat Foot	220 (1.98%)	722.1 Displacement of Thoracic or Lumbar Intervertebral Disc w/o Myelopathy	214 (1.80%)

The most common ICD-9-CM diagnoses among Soldiers who ultimately received a musculoskeletal disability varied slightly over time (Table 15), though pain in joint and lumbago were consistently the top two causes of musculoskeletal conditions throughout the time period. Between 1984 and 1989, joint derangement, along with pain in joint and lumbago, were the top three most common ICD-9-CM diagnoses associated with musculoskeletal conditions. From 1990 to 1994, osteoarthrosis was the third most common clinical diagnoses for those who ultimately received a musculoskeletal disability discharge, and by 1995-1999, pain in limb was among the most common top three diagnoses. All ICD-9-CM diagnoses associated with musculoskeletal disability through our entire study period remained with the clinical musculoskeletal category.

Table 15. Top 10 most common ICD-9-CM diagnoses for Musculoskeletal Conditions by era.

Era	ICD-9-CM Code (Number and Title)	Frequency and Percent
1984-1989	719.4 Pain in Joint	747 (11.12%)
	724.2 Lumbago	665 (9.90%)
	718.8 Joint Derangement, Not Elsewhere Classified	422 (6.29%)
	717.7 Chondromalacia Patellae	353 (5.26%)
	716.1 Traumatic Artropathy	282 (4.20%)
	717.8 Other Internal Derangement of the Knee	224 (3.33%)
	734 Flat Foot	217 (3.23%)
	715.3 Local Osteoarthritis, Unspecified	214 (3.19%)
	715.9 Osteoarthrosis, Unspecified	208 (3.10%)
	722.1 Displacement of Thoracic or Lumbar Intervertebral Disc w/o Myelopathy	177 (2.64%)
1990-1994	719.4 Pain in Joint	1,435 (16.32%)
	724.2 Lumbago	1,016 (11.55%)
	715.9 Osteoarthrosis, Unspecified	370 (4.21%)
	718.8 Joint Derangement, Not Elsewhere Classified	366 (4.16%)
	717.7 Chondromalacia Patellae	320 (3.64%)
	716.1 Traumatic Artropathy	304 (3.46%)
	717.8 Other Internal Derangement of the Knee	300 (3.41%)
	722.1 Displacement of Thoracic or Lumbar Intervertebral Disc w/o Myelopathy	224 (2.55%)
	734 Flat Foot	215 (2.44%)
	729.5 Pain in Limb	212 (2.41%)
1995-1999	719.4 Pain in Joint	2,196 (22.98%)
	724.2 Lumbago	1,677 (17.55%)
	729.5 Pain in Limb	394 (4.12%)
	719.8 Other Specified Disorders of the Joint	304 (3.18%)
	733.1 Pathological Fracture	281 (2.94)
	718.8 Joint Derangement, Not Elsewhere Classified	269 (2.81%)
	715.9 Osteoarthrosis, Unspecified	266 (2.78%)
	717.7 Chondromalacia of Patella	237 (2.48%)
	722.1 Displacement of Thoracic or Lumbar Intervertebral Disc w/o Myelopathy	212 (2.22%)
	734 Flat Foot	183 (1.91%)

DISCUSSION

For many of the VASRD groupings, the corresponding ICD-9-CM diagnoses demonstrate good face validity. That is, the most commonly assigned ICD-9-CM codes are consistent with the given VASRD condition group. However, in some cases the clinical diagnoses do not appear to be directly associated with the primary VASRD disability code. For example, while most cardiovascular disability cases have a corresponding clinical diagnosis that logically relates to cardiovascular disease, it is curious that the top second and third diagnoses from the CRO records for Soldiers ultimately discharged with a primary VASRD code of cardiovascular disability were related to neurological and/or musculoskeletal disorders. Pathological fractures and pain in limb were historically used to code stress fractures (in the absence of any other code) and also sometimes used to indicate bone cancer. It is unclear why it would be such a common diagnosis among Soldiers ultimately discharged with cardiovascular disease. It may be that the same factors, for example, elevated cholesterol or obesity, that contribute to fractures may also increase risk for cardiovascular disease. Still, we would have expected pain in limb to be more closely associated with the musculoskeletal disability group. It may be that musculoskeletal disability is so common that it is a common secondary condition or morbidity even among those discharged primarily for another cause of disability. The order for listing disability conditions (there can be up to four VASRD codes assigned to the disabled Soldier) may reflect significance or severity of the specific disabling condition and/or amount of compensation associated with that condition. Because these analyses use only the primary VASRD code and the primary ICD-9-CM code, this may explain the presence of what appear to be musculoskeletal disorder diagnoses in hospital records for Soldiers discharged primarily for cardiovascular disease disability.

Extreme heterogeneity within some VASRD groups, such as infectious, immune, and nutritional disorders; hemic and lymphatic systems; and gynecological and breast disorders, and within the underlying clinical diagnoses associated with these conditions substantially impede the utility of these data for surveillance and research purposes. While the actual ICD-9-CM codes associated with these broad VASRD groups were not inconsistent with the types of conditions that one would expect to find in these categories, the widely differing etiologies of these conditions suggest combining them makes little sense from a clinical perspective and also renders each of these broad disability groups or categories of little use for research purposes. Given the different etiologies of infectious diseases versus autoimmune disorders, the infectious disease, immune disorders, nutritional deficiency VASRD group, in particular, may be among the most eclectic in its composition.

The gynecological and breast VASRD group also poses some problems, at least with regard to meaningful interpretation of findings using this VASRD group. Though most of the clinical conditions linked to the gynecological and breast disorder VASRD group are diagnoses usually specific to only women, not all are. For example, men can have neoplasm of the breast and abdominal pain. It is not clear where male neoplasm of the breast would be coded in the VASRD system. Similarly, it is not clear where

abdominal pain for men, the fourth most common clinical diagnoses within the gynecological and breast disability VASRD group, would be coded under the VASRD system. It might be placed within the diseases of the digestive system disability group if it led ultimately to a compensable long-term problem. Another challenge, in addition to the apparent tendency to lump any condition common to women in this VASRD group (whether it actually pertains only to female reproductive system or not) is the variation in the type of conditions listed. The conditions included in this VASRD group vary both by body part or system affected and etiology. These variations suggest caution should be used in interpreting the significance of gynecological and breast disability disorders and in comparing the incidence of some types of disability (e.g., abdominal pain) among male and female Soldiers. Consideration should be given to revising this VASRD category to improve clinical clarity.

Care should be taken when trying to analyze any of these three heterogeneous VASRD groups because of the diversity of underlying clinical diagnoses represented within these broad VASRD disability categories. To improve utility and clinical relevancy, this VASRD group should be changed to at least separate infectious from other disease processes. More research and disability coding policy change is suggested by these findings. Researchers focused on these types of conditions will need to conduct analyses at a more refined subcategory level, rather than working with the broad VASRD group. Furthermore, because some of the conditions coded as gynecological and breast conditions may not, in fact, be truly gender-specific, care should be taken when comparing male and female rates for some conditions (e.g., malignant neoplasm of the breast, abdominal pain).

Musculoskeletal conditions are the most common type of permanent disability discharge from the U.S. Army and have been for over two decades. What's more, disability related to musculoskeletal conditions has increased as a proportion of the total disability burden over time. By identifying the most common ICD-9-CM diagnoses experienced by Soldiers who eventually receive musculoskeletal disability, we can target such conditions and incorporate them into intervention planning efforts. The primary clinical conditions experienced by those hospitalized and ultimately discharged from the Army with a musculoskeletal disability condition were pain in joint, lumbago, joint derangement, chondromalacia patellae, and osterarthrosis. These are all diseases of the musculoskeletal system and connective tissue (710-739). There are a number of risk factors for these conditions including acute injury and body composition factors, such as greater body mass index (BMI) and stature (very tall or very short). The high incidence of knee- and back-related disorders may be indicative of occupational exposures, such as high-impact physical training or job demands (17, 18, 21, 30), or heavier BMI or overweight (11, 15, 23, 24, 26, 29, 32).

Joint pain, or arthralgia, was the most commonly assigned primary diagnosis among Soldiers discharged with a musculoskeletal disability. Joint pain may result from a number of causes and reflect a number of different underlying clinical conditions including, arthritis, osteoarthritis, gout, fibromyalgia, autoimmune disorders such as lupus, bursitis, tendonitis, and acute injury or trauma (16). This is also a common diagnosis within the general population. It is associated with increasing age and is

more common among women than men. Studies also suggest that joint pain is commonly reported among Gulf War Veterans. Joint pain was the most common complaint reported by participants in the Comprehensive Clinical Evaluation Program for Gulf War veterans in 1995. In addition, it was the most common ICD-9-CM diagnosis within the musculoskeletal conditions group for Gulf War veterans (8, 20, 31).

Lumbago, or unspecified low back pain, was the second most commonly occurring ICD-9-CM diagnoses among Soldiers with a CRO record who were discharged from the Army with permanent disability. Lumbago was also the second most frequently identified ICD-9-CM condition within the ICD musculoskeletal group among Gulf War veterans (8). Causes of lumbago may be acute trauma or residual pain from old injuries (e.g., after lifting something heavy or overuse), or it may often have an unknown etiology. Two of the top ten conditions are back-related diagnoses and two are related to knee pain or injury. Because other diagnoses are nonspecific with regard to body part, it is possible that some of these other nonspecific joint pain or osteoarthrosis conditions may also involve the knee or back. This is important clinical information that should be used to guide future analysis of musculoskeletal disability risk factors.

Arthritis and periostitis were common diagnoses within the musculoskeletal disability group. These involve inflammation around joints or of the tissue that is wrapped around bones (inflammation around the bones). Sometimes the latter is called shin splints if it affects bones of the lower leg. While there is not enough data yet to formulate theories regarding the increasing incidence of musculoskeletal disability, it does appear that much of the growing problem of disability is related to overuse and possibly acute injury to the back, knee, and possibly other joints. There are a number of hypotheses that could be tested to help clarify the etiology of this increasing disability problem. Changes in occupational exposures, for example, may be contributing to an increased risk for knee and back problems. The advent of better protective gear may save lives during battles and crashes, for example, but may also have the unintended consequence of increasing stress on the spine or lower extremities and ultimately contribute to musculoskeletal disability (3). A more rigorous physical fitness training program, as well as improvements in medical care management and possibly diet may have resulted in lowered risk for cardiovascular disease, but perhaps the primary aerobic training methods (marching, walking, running) have contributed to knee and back disability. Finally, in the civilian sector, obesity and body mass have increased over time (12, 27). Within the military population, there have also been increases in BMI concurrent with an apparent increase in some measures of strength (grip strength has increased over time), but no improvement in muscular endurance (number of situps and pushups in 2-minute timed interval) and possible decrease in aerobic fitness (run time) (19). Both body fat and fat-free mass of male Army recruits have increased over time, while data on female recruits was more variable. Thus, many of the underlying clinical conditions associated with the rapidly growing musculoskeletal disability group reflect problems that often are consistent with bearing heavier weight or being overweight, and with exercising too much and/or exercising while bearing too much weight. Future work should attempt to test these hypotheses.

Only musculoskeletal disability and disability related to respiratory conditions increased over the study period. By far, the fastest growing and largest category of disability was musculoskeletal disability, but the addition of Asthma to the most common diagnoses list in the latter part of the study period is worth noting. This may simply reflect an increase in screening and/or case-finding, or it may reveal a pattern of increasing incidence of asthma as a co-morbid condition. An increase in asthma has also been similarly documented in the general U.S. population (13, 25).

Musculoskeletal disability comprises about 2/3 of the entire disability population. While it has always been the largest disability group, it has grown as a relative proportion of all disability over time. The major subcategories of musculoskeletal disability are labeled "Injury" and "Disease," with "Injury" occupying a somewhat larger position (55% versus 44% of musculoskeletal conditions, respectively). Despite the distinction in category labels, both "Injury" and "Disease" musculoskeletal conditions primarily describe or capture clinical conditions within the 710-739 range (Diseases of the musculoskeletal system and connective tissue) section of the ICD-9-CM codebook. This may reflect that fact that sequelae of acute injury are essentially "chronic" conditions by the time someone is discharged from the Army, and a label of "Injury" may reflect the etiology of the condition better than the nature of the condition. Thus, it is not clear how meaningful subcategory analyses of the musculoskeletal conditions would be.

STRENGTHS AND LIMITATIONS

The most significant limitation to this study is the lack of disability-evaluation-related hospital record data on all individuals who are eventually discharged from the Army with a permanent disability. Furthermore, the phasing out of CRO records also may limit generalizability of findings to more recent disability cases. Despite this limitation, analysis of the demographic composition of those with and those without a CRO suggest that the populations are quite similar; there is not evidence of possible bias with regard to demographic characteristics. There are some interesting differences with regard to the types of disabilities that receive a CRO record, with mental health disorders being notably less likely to have a corresponding CRO record.

Second, in order to make this analytic effort manageable, we focused on primary ICD-9-CM clinical diagnoses and on the primary (first) VASRD code. Thus, it is possible that we are missing important linkages or patterns between certain clinical conditions and certain VASRD codes. We may miss, for example, common comorbidities. On the other hand, the consistency between ICD-9-CM diagnoses and primary VASRD groupings suggests that this approach is reasonable for the purposes of assessing how well VASRD group maps to clinical group. Future research efforts would benefit from greater exploration of secondary clinical diagnoses and secondary disability groupings.

Despite these limitations, this study was still able to provide a detailed picture of how ICD-9-CM clinical diagnoses relate to disability discharges. Our ability to link hospital data with disability data at the individual level is a unique strength of this study.

Using the TAIHOD database, we were able to study a relatively large sample of Soldiers over a 25 year period, with hospital records available for 32,524 Soldiers who eventually received a permanent disability discharge from the Army.

CONCLUSIONS

This report describes the association between VASRD disability codes and clinical diagnoses assigned during disability-related hospitalizations. The most common ICD-9-CM diagnoses varied, as expected, by broad VASRD groupings. Overall, the diagnostic categories most common in disability-related hospital records generally link in a logical way to the broad VASRD categories assigned in a discharge for permanent disability. However, for some VASRD groups, such as infectious disease, immune disorders, nutritional deficiencies; hemic and lymphatic systems; and gynecological and breast problems, there is a lot of variation in the types of clinical conditions included. This extreme heterogeneity may make these VASRD groups less clinically interpretable when analyzing trends, or when using these groups as part of a larger surveillance or epidemiological research effort. In addition, consideration should be given, from a policy-level, to revising and modifying these VASRD categories and for inclusion of ICD-9 CM diagnostic codes in the PEB disability database, especially since they are readily available to the PEB record system already. They were initially excluded because of space considerations and data storage limitations. However, with the advent of much more efficient computers with substantial storage capabilities, this no longer appears to be a salient argument for excluding the diagnostic codes.

Musculoskeletal disabilities are the most common cause of disability among Army Soldiers, and low back pain (lumbago) and joint pain comprise a majority of the underlying clinical diagnoses. These clinical diagnoses were consistently among the most common throughout the entire study period. The increasing risk for musculoskeletal disability suggest that more research is needed to understand underlying risk factors for these conditions and, in particular, why the risk is increasing. The hypotheses described above should be tested, in particular whether or not increasing BMI may explain, in part, the increased risk for musculoskeletal disability.

The ability to link disability-related hospitalizations to VASRD codes assigned in a permanent disability discharge can inform research and allow a better understanding of the natural history of disability within the Army. Future efforts should focus on assessing the face validity of more current VASRD codes perhaps by linking to the MEBITT data or other sources of information on clinical diagnoses associated with disability cases. Research on the link between secondary or comorbid clinical conditions and specific VASRD primary and secondary codes is also warranted.

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Appendix B

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The changing profile of disability in the U.S. Army: 1981-2005

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Abstract

Background: We sought to provide a profile of U.S. Army soldiers discharged with a permanent disability and to clarify whether underlying demographic changes explain increasing risks.

Methods: Frequency distributions and logistic regression analyses describe active-duty Army soldiers discharged with a disability (January 1981 through December 2005; N = 108,119). Time-series analysis describes temporal changes in demographic factors associated with disability.

Results: Disability risk has increased 7-fold over the past 25 years. In 2005, there were 1,262 disability discharges per 100,000 active-duty soldiers. Risk factors include female gender, lower rank, married or formerly married, high school education or less, and age 40 or younger. Army population demographics changed during this time; the average age and tenure of soldiers increased, and the proportion of soldiers who were officers, women, and college educated grew. Adjusting for these demographic changes did not explain the rapidly increasing risk of disability. Time-series models revealed that disability among women is increasing independently of the increasing number of women in the Army; disability is also increasing at a faster pace for younger, lower-ranked, enlisted, and shorter-tenured soldiers.

Conclusion: Disability is costly and growing in the Army. Temporal changes in underlying Army population demographics do not explain overall disability increases. Disability is increasing most rapidly among female, junior enlisted, and younger soldiers.

Keywords: Disability; Army; Musculoskeletal; Injury; TAIHOD; VASRD

Disability is a large and growing problem in both military and civilian populations in the United States. Among working-age civilians, the rate of persons receiving benefits for a permanent disability rose approximately 40% between 1990 and 1999 [1]. The costs of occupational disability among civilian populations in the United States in 1997 were estimated at approximately $182.6 billion. Moreover, per capita medical expenses for adults aged 18 or older were 5 times greater for the disabled than for the nondisabled population [2]. Public benefits for all disabled beneficiaries in the United States amounted to almost $76 billion in 2005 [3].

The economic costs of disability to the U.S. military and the Department of Veterans Affairs (VA) are staggering. In fiscal year 2005, the Department of Defense (DoD) paid disability-retired military service members $1.25 billion, $474 million of which was for disabled Army retirees [4]. The VA made estimated disability payments of $29 billion in 2005 [5,6]. While *total* medical care costs for disabled Army soldiers are unknown, VA facility treatment costs for Army soldiers with a medical discharge between 1986 and 1995 were estimated at approximately $124 million in 2001 alone and the cost of running the VA medical system is on the order of $25 billion annually, with most of this care rendered to disabled veterans [6,7]. These costs are bound to increase dramatically once soldiers with disabilities related to Operation Iraqi Freedom are processed and enter the DoD and VA systems.

Reductions in military occupational productivity prior to disablement, wage losses of disabled individuals and any caretakers, inability to perform household tasks, and

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decreased quality of life due to the disabling condition are not factored into the costs of disability [8,9]. Recruitment and replacement training costs, as well as costs of losing experienced employees, are not estimated. Similarly, medical care for the condition prior to disablement and administrative costs associated with evaluating and processing disability are not well documented. Also hard to quantify are the costs associated with the Army's investment in training and maintaining soldiers whose careers are later cut short by a disability.

Despite the large and growing problem of disability among military populations, relatively few studies have described occupational or demographic risk factors. Between 1981 and 2002, the number of active-duty Army personnel fell by 37% as part of an overall downsizing effort [10]. At the same time, soldiers reported poorer physical and mental health and increased levels of stress, depression, anxiety, and occupational stress compared with their civilian peers [11,12]; these factors may be associated with increased risk for subsequent disability. Although studies of disability among Army soldiers are limited, with most of the published studies focused primarily on a particular type of musculoskeletal condition (e.g., knee injury), there is some evidence suggesting that female soldiers are at greater risk for injuries, illnesses, and medical disability discharge than are men [13-16]. Estimates of the excess risk of discharge for injuries among females compared with males in the military range from 2.5:1 [15] to 7.0:1 [14]. The authors postulate that lower levels of physical fitness and endurance [15], differences in strength, or ergonomic differences [14], as well as a greater likelihood of seeking medical care [17], may explain the gender differences. Age has also been associated with risk of occupational disability, but the direction of the association has been inconsistent in studies of Army populations and the few studies available focus only on musculoskeletal injury [16,18]. The relationship between age and occupational disability may not be linear and probably interacts with gender or other factors [16]. Age may also be confounded by other factors such as rank and time in service, as older individuals are more likely to be in higher ranks and have longer service experience and consequently less likely to be in highly physically demanding jobs that cannot be performed with physical limitations [19,20].

In assessing increasing trends in disability, it is important to clarify what proportion of these increases may be attributable to changes in the demographic characteristics of the U.S. Army population at large and what proportion of increased disability rates remains unexplained or requires greater investigation in order to uncover the etiology. At the same time as the risk of disability has increased, the demographic profile of active-duty soldiers has changed. From 1985 to 2005, the ratio of males to females in the Army declined [21] and the average age of soldiers increased [11]. It is important to separate the effects of demographic shifts from real changes in disability risk.

Aims

The objectives of this descriptive study were to (1) document and describe the overall population of soldiers discharged from the Army with a permanent disability; (2) to determine whether temporal changes in the demographic composition of the Army population explain the increasing risk of disability discharge; and (3) to describe temporal changes in the demographic profile of those who are disabled in order to better inform interventions and future analytic work.

Methods

Data sources

Data come from the Total Army Injury and Health Outcomes Database (TAIHOD), a compilation of files containing demographic and health information on active-duty Army personnel that can be linked through individual identifiers [22-24]. TAIHOD components used for this paper included the Defense Manpower Data Center (DMDC) personnel records, which provide demographic and discharge information and disability board records from the U.S. Army Physical Disability Agency.

Sample

The total sample of all active-duty Army soldiers discharged with permanent disability between January 1981 and December 2005 included in this analysis is 108,119 soldiers.

Measures

Disability outcome measure

DoD Directive 1332.18 defines *disability* as ''Separation from the Military Service by Reason of Physical Disability'' (1996). The disability can be caused by, aggravated by, or even unrelated to military service. DoD Directive 1332.18 and 10 U.S. Code, Ch. 61 outline the requirements and procedures for separations due to a physical disability with the primary requirement being that the soldier must be unfit to carry out duties of his or her rank, office, or grade due to a physically disabling condition that substantially limits or precludes fulfillment of the purpose of their active-duty employment [25,26].

Soldiers whose physical or mental health conditions make them unlikely to return to active duty despite having received optimal medical treatment for their condition are referred to a medical evaluation board (MEB). The MEB reviews all available medical and occupational evidence and may make a recommendation regarding the need for another disability evaluation, which is performed by the physical evaluation board (PEB). Following PEB evaluation, if a determination of unfitness is made, the PEB further determines if the condition is stable (no further improvement expected). Stable conditions are eligible for

a permanent disability discharge. When the PEB evaluation finds that there is some potential for improvement in the condition, the soldier may be recommended for the Temporary Disability Retired List after which he or she will be reevaluated periodically over the ensuing 5 years to assess his or her ability to return to active duty [27]. Only confirmed permanent disabilities with a record of discharge from the Army were analyzed in this study.

Type of disability

The Army uses the Veterans Administration Schedule for Rating Disabilities (VASRD) to describe and rate disabilities (38 C.F.R. 4). Organized into 16 body/organ system groups, the VASRD describes functional limitations that can be used as the basis for a percentage of disability. Causes or major types of disability are defined in the VASRD. They fall into the following categories: musculoskeletal conditions; neurological conditions; mental health disorders; cardiovascular conditions; respiratory conditions; endocrine disorders; digestive conditions; diseases of the eye; skin disorders; genitourinary conditions; infectious diseases, immune disorders, and nutritional disease; hemic and lymphatic disorders; diseases of the ear; diseases of other sensory organs; gynecological conditions; and dental and oral conditions.

Demographic covariates

Demographic covariates included gender, age, race, marital status, education, and time in service. Age is coded as less than 21 years, 21-25 years, 26-30 years, 31-35 years, 36-40 years and greater than 40 years; race is categorized as white, black, Hispanic, and other; marital status includes single (never-married), married, and previously married (i.e., widowed, divorced, or legally separated); education is coded as less than or equal to high school degree (or degree equivalent), some college, and completed college or above; rank was coded for enlisted personnel as Junior (E1-E4), Mid-level (E5-E6), and Senior (E7-E9) and for Officers as Warrant Officer (W1-W5), O1−O3, O4−O5, and O6−O11; and total time in service at time of discharge was coded as less than 1 year, 1+ to 2 years, 2+ to 3 years, 3+ to 4 years, 4+ to 5 years, 5+ to 7 years, 7+ to 10 years, 10+ to 15 years, and greater than 15 years.

Data analysis

Frequency distributions and odds ratios from bivariate logistic regression models were used initially to describe the demographic characteristics of soldiers discharged with a permanent disability. Risks for disability discharge were calculated by dividing the total number of active-duty soldiers discharged with a permanent disability by the total number of soldiers on active duty during that year based on DMDC personnel file data. A soldier on active duty at any time during a calendar year counted toward the annual denominator. To control for temporal shifts in discharge from the Army, we also examined risk of disability discharge just among soldiers who were discharged from the Army in a given year. Because trend lines were very similar when we used either total population or total discharges as the denominator, we only report findings using the total army population, instead of discharges, as the denominator with disability risks reported per 100,000 active-duty soldiers in that year. This allows for greater comparability with nonmilitary data. To assess the influence of temporal changes in the Army's demographic profile on the annual risk for disability, unadjusted risks for disability discharge were plotted alongside risks adjusted for temporal changes in gender, race, age, and time in service. Data were directly standardized to the 1981 Army population profile.

Autoregressive time-series analytic models were also used to assess temporal changes in the demographic profile of soldiers discharged with a disability for the years 1981 through 2005. In time-series data, error terms may be serially correlated, yielding bias in ordinary regression models. Autoregressive models correct for the autocorrelation between data in a related series (i.e., years 1982 through 2005). Stepwise autocorrelation selects the order of the autoregressive error model (i.e., AR1, first-order autocorrelations that adjust for the prior 1 year; AR2, second-order autocorrelations that adjust for 2 years prior). The Durbin-Watson test is used to test for the presence of autocorrelation; when it is not significant, the model has effectively reduced the bias due to autocorrelation. The ARCHTEST disturbances (i.e., Q statistics test and Lagrange Multiplier test) are used to test for heteroscedasticity of error variance [28]. When these statistics are not significant, the error variance is considered homoscedastic. In separate analyses, rates of permanent disability per 100,000 population for specific demographic groups were regressed on years of study period (1981-2005). Log transformation was applied and temporal estimates from the autoregressive models are interpreted in terms of percent change by taking the exponent of the obtained estimate.

Analyses were conducted using SAS versions 8.2 and 9 (SAS Institute, Cary, NC). All analyses for this project adhere to the policies for the protection of human subjects as prescribed in Army Regulation 70-25, and with the provisions of 45 C.F.R. 46.

Results

Between 1981 and 2005, 2,724,359 soldiers were discharged from the Army and, of these, about 4% left the Army with a documented permanent disability (N = 108,119). While the overall Army population has decreased from 922,448 in 1981 to 564,802 in 2005, the number of disability cases each year has actually increased from 1,641 in 1981 to 7,126 in 2005.

The annual disability discharge risk per 100,000 population increased by over 600% between 1981 and 2005.

Although there was some volatility in disability risk between individual years of the study period, the overall trend has been increasing, representing an average annual increase of nearly 10% per year over the past 25 years. In 1981, the risk of disability discharge was 178 per 100,000, but by 2005 the risk had climbed to 1,262 per 100,000 soldiers on active duty that year (data not shown).

Table 1 describes the demographic characteristics of soldiers discharged with a permanent disability compared with those soldiers discharged from the military without a disability during the study period. Soldiers discharged with a permanent disability between 1981 and 2005 were more likely to be female, older than 21 but less than 40 years of age (31- to 35-year-olds were at greatest risk), married or previously married, mid-level or junior enlisted (as opposed to senior enlisted or officers), and significantly less likely to have a college education.

Over the 25-year study period, the overall demographic profile of the Army at large changed. There was a shift toward greater female representation (the proportion of female soldiers in the Army increased from 10% in 1981 to 15% by 2005). The proportions of white and black soldiers declined (63% to 61% and 29% to 22%, respectively), while the Hispanic population increased from 4% to 11% and ''other'' racial and ethnic groups (as a whole) increased from 4% to 7%. The proportion of officers in the Army increased from 10% to 13%, while the proportions of enlisted soldiers declined from 88% to 85%. The average age of the population also went up, most notably increasing among those aged 36 or older while younger age groups experienced a relative decrease. The average time in service of active-duty soldiers shifted toward a greater proportion of soldiers remaining on active duty past 10 years. Between 1981 and 2005 the proportion of soldiers on active duty for less than 2 years declined from 39% to 31%; those with 2 to 5 years or 6 to 10 years of total active service remained relatively stable (32% to 31% and 14% to 15%, respectively, between 1981 and 2005). Those with greater than 10 years of active service increased from 15% to 24% over the same time period. The percentage of soldiers with a college degree increased from 19% to 21%, although there was a great deal of temporal volatility with proportions of college-educated soldiers varying over the study period (data not shown).

To assess the hypothesis that changes in the underlying Army population as a whole explain all or part of the increasing disability trends, the unadjusted disability risk per 100,000 population and disability risks adjusted for changes in gender, race, age, and total time on active duty were plotted side by side (Figure 1). The lack of an effect on the disability risk after standardization suggests that changes in underlying population characteristics do not explain the increasing risk of disability over the time period.

In order to begin to understand the underlying etiology of the increasing risk for disability it is important to determine whether identified risk factors (see Table 1) are constant or whether they, too, are changing. That is, is the overall profile of disability changing in the Army? Figures 2 through 6 show changes in the risk of disability over time by key demographic subpopulations (gender, age, time in service, rank, and educational groups) and suggest that the profile of soldiers who experience disability has changed over the time period. Risk of disability discharge per 100,000 women and per 100,000 men are both trending up, but since about 1990, the risk of disability for female soldiers has been increasing at a faster pace than the risk for male soldiers (Figure 2). Significant changes in risk for disability by gender were tested in autoregressive

Table 1
Demographic Characteristics of Discharged Soldiers With and Without Permanent Disability*; Unadjusted Odds Ratios From Logistic Regression Models

Characteristic	Without disability (%)	With disability (%)	Odds ratio	95% Confidence interval
Gender				
Men	96.22	3.78	1.00	
Women	94.85	5.15	1.37	1.35-1.39
Age, y				
<21	97.21	2.79	1.00	
21-25	96.68	3.32	1.18	1.16-1.20
26-30	94.53	5.47	1.97	1.93-2.02
31-35	92.26	7.74	2.85	2.78-2.92
36-40	95.32	4.68	1.68	1.63-1.73
>40	97.20	2.80	0.97	0.94-1.00
Race				
White	96.02	3.98	1.00	
Black	96.04	3.96	1.00	0.98-1.01
Hispanic	95.84	4.16	1.01	0.99-1.04
Other	96.48	3.52	0.94	0.92-0.97
Marital status				
Single	96.97	3.03	1.00	
Married	95.04	4.96	1.69	1.68-1.71
Previously married	94.57	5.43	1.83	1.77-1.89
Education				
≤High school	95.87	4.13	1.00	
Some college	95.64	4.36	1.07	1.04-1.10
≥College degree	97.08	2.92	0.69	0.67-0.71
Rank				
Junior enlisted (E1-E4)	96.23	3.77	2.52	2.24-2.84
Midlevel enlisted (E5-E6)	94.23	5.77	3.91	0.85-1.12
Senior enlisted (E7-E9)	96.94	3.06	2.01	1.78-2.27
Warrant officer	96.95	3.05	1.64	1.43-1.88
Junior officer (O1-O3)	97.37	2.63	1.65	1.46-1.87
Midlevel officer (O4-O5)	98.49	1.51	0.97	0.85-1.12
Senior officer (O6-O11)	98.44	1.56	1.00	
Time in service				
<1 year	97.16	2.84	1.06	1.03-1.09
1-2 years	94.77	5.23	2.12	2.06-2.18
>2-3 years	97.01	2.99	1.17	1.14-1.20
>3-4 years	97.22	2.78	1.09	1.06-1.13
>4-5 years	94.97	5.03	2.02	1.96-2.09
>5-7 years	94.68	5.32	2.12	2.06-2.18
>7-10 years	93.94	6.06	2.48	2.41-2.55
>10-15 years	91.81	8.19	3.43	3.33-3.53
>15 years	97.43	5.57	1.00	

* Excludes soldiers discharged with temporary disability from analysis.

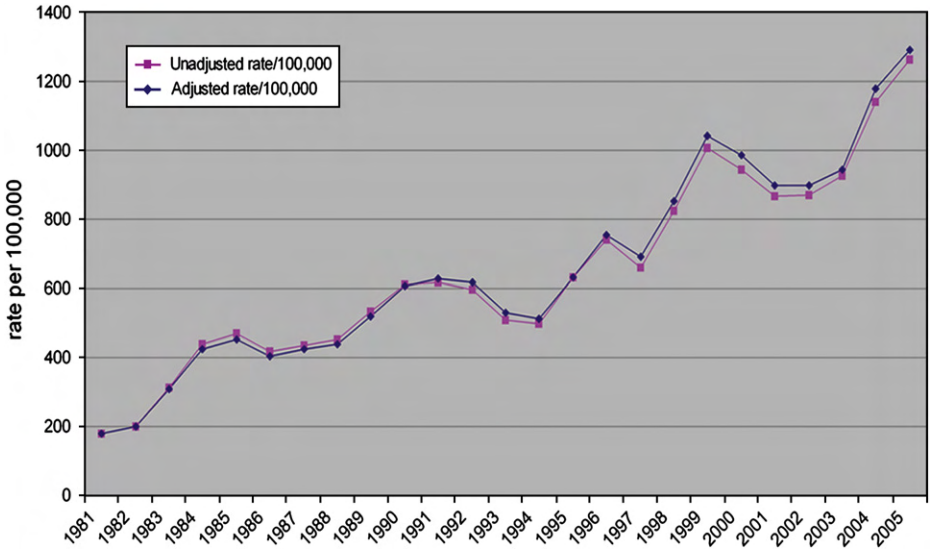

Figure 1. Adjusted and unadjusted disability per 100,000 active-duty Army population risks, 1981-2005. Risks standardized (adjusted for age, gender, time in service, race/ethnicity) to 1981 demographic composition.

time-series models (Table 2). Based on the gender specific risks of permanent disability shown in Figure 2, autoregressive models yielded statistically significant temporal patterns among female ($p < .001$) and male ($p < .001$) soldiers. Specifically, the rates for female soldiers increased by 8% with each successive year while the rates for male soldiers increased by 5% with each increasing year.

Figure 3 depicts age-specific risks for disability. In the beginning of the study period, 21- to 30-year-olds were among those at lowest risk for disability. But by 1990 their risk had increased rapidly, surpassing all other age groups. In contrast, those over age 40 were initially at greatest risk, but by the late 1990s their risk of disability had dropped to the very bottom of the group (Figure 3). Autoregressive models yielded statistically significant temporal patterns for soldiers under the age of 36. Specifically, the disability risks for soldiers aged 35 and younger increased by 7% with each increasing year ($p < .001$). While the disability risks for soldiers aged 36 and older decreased by 1% with each increasing year, the temporal pattern was not statistically significant for soldiers 36 and older (see Table 2 and Figure 3). Thus, even though the Army at large is getting older and staying on active duty longer, soldiers discharged with a disability are getting younger.

Figure 4 shows time in service. As with the age depictions in Figure 3, data indicate that risk for disability discharge among soldiers with the longest tenure declined while disability risks among soldiers with less than 10 years

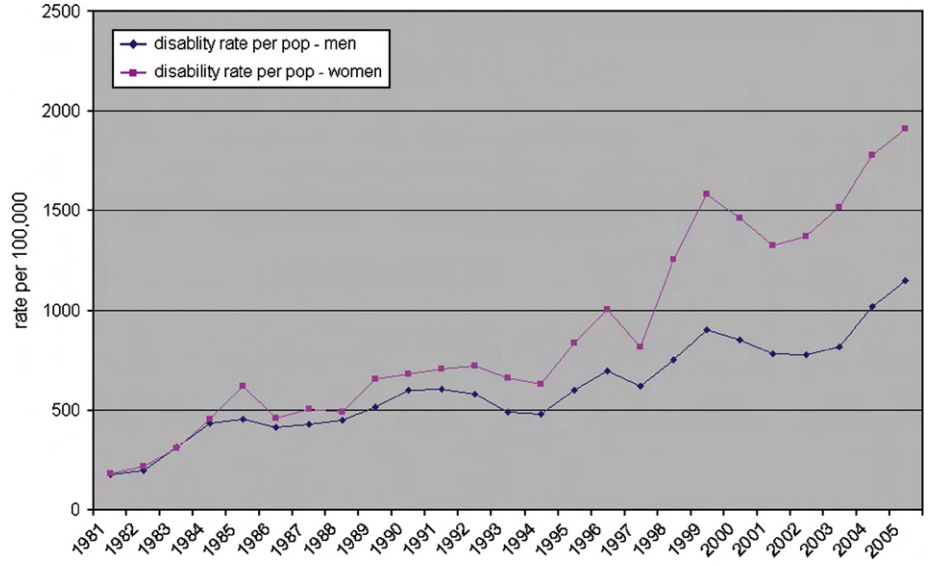

Figure 2. Gender-specific disability risks per 100,000 population, 1981-2005.

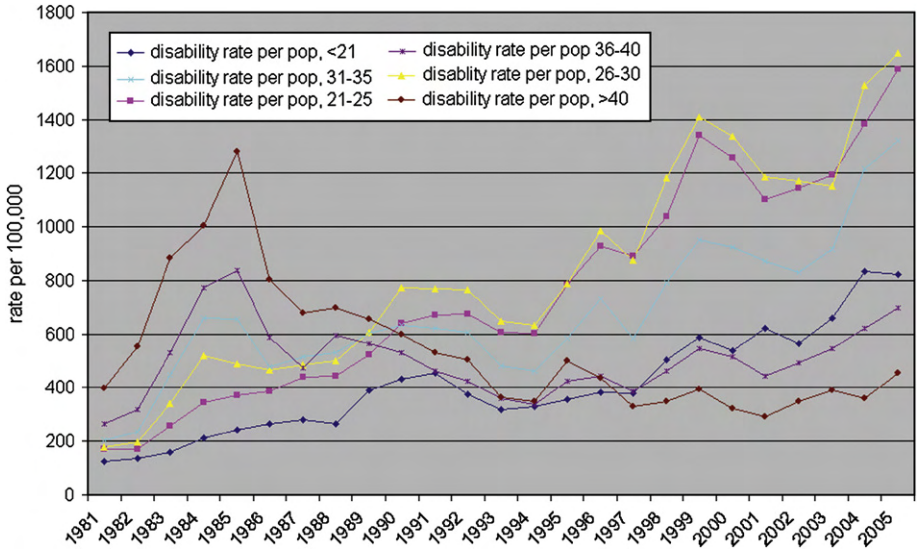

Figure 3. Age-specific disability risks per 100,000 population, 1981-2005.

of active service increased. The increase has occurred most precipitously among soldiers with 2 to 5 years followed by 6 to 10 years of active service. The risk for permanent disability among soldiers with less than 2 years of service increased by 6% with each increasing year and the risks among soldiers with 2 to 10 years of service increased by 8% with each increasing year ($p < .001$) (see Table 2 and Figure 4).

Figure 5 shows the association between rank and disability over the study period. The disability risks among officers and warrant officers were relatively stable until about 1998, at which point they began to climb. The risk of disability among enlisted soldiers was initially similar to officers, but during the late 1980s rates among lower ranking enlisted soldiers began to climb steeply and have continued to outpace the pattern of increased risk observed among officers, warrant officers, and higher-ranking enlisted soldiers. Autoregressive models indicate that the service-specific rate of permanent disability among commissioned and warrant officers increased by 2% for each increasing year ($p < .05$) (see Table 2). Among enlisted soldiers in grades E1 through E3, disability increased by 8% ($p < .001$), and the risk for permanent disability among enlisted soldiers in grades E4 and E5 increased by 4% for each increasing year ($p < .001$). In contrast, the risk of permanent disability among senior enlisted soldiers (E6 through E9) actually decreased by 3% with each increasing year ($p < .02$).

College education appears to have an increasingly protective effect on disability over the study period (at least

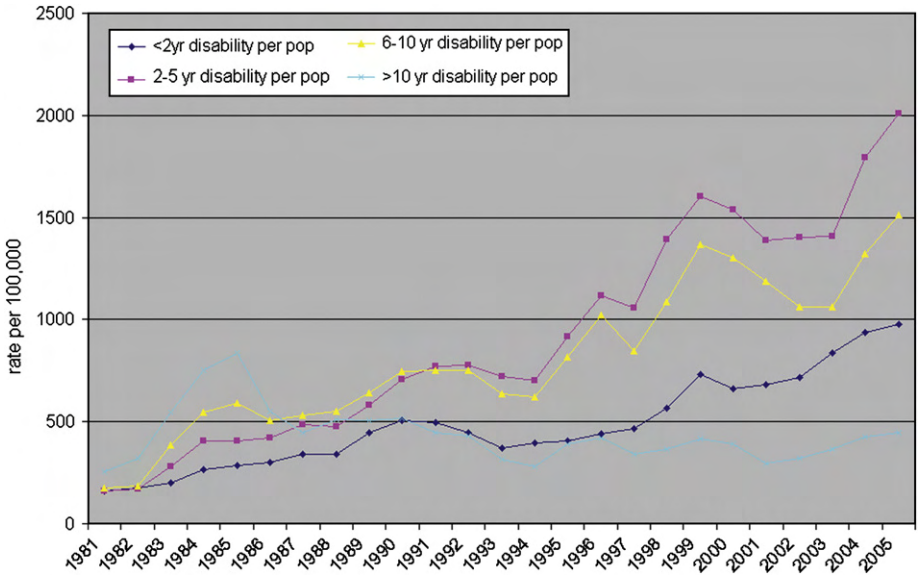

Figure 4. Total time in active military service disability risks per 100,000 population, 1981-2005.

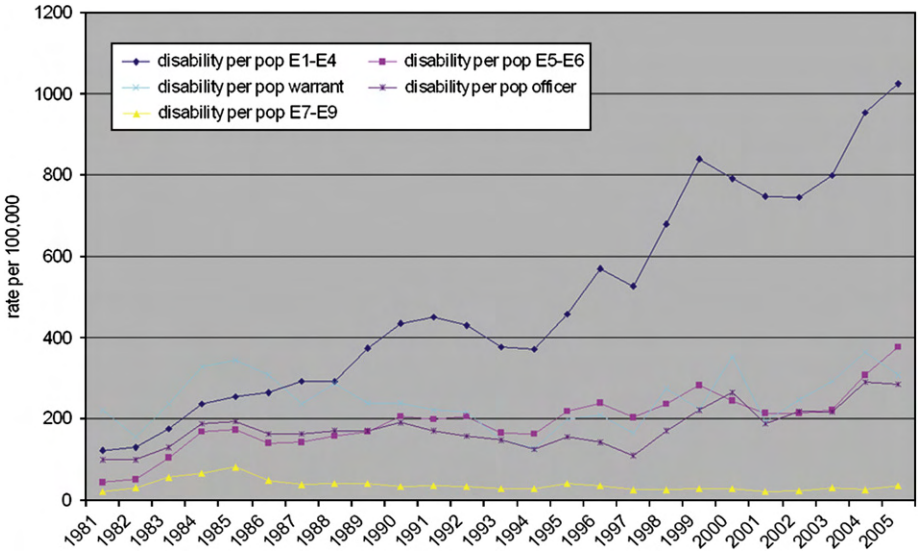

Figure 5. Rank specific disability risks per 100,000 population, 1981-2005.

in analyses adjusted for education only, but not for other factors often associated with education) (Figure 6). Since about 1986, risk for disability among those without college education continued an upward trend started in 1981. But those with a college education actually experienced a drop in disability followed by a relatively long period of stability. In the late 1990s, the risk of disability among those with a college degree also began to rise, but it was still much lower than the risk among soldiers without a college degree. Autoregressive models yielded statistically significant temporal patterns based on education-specific risks for permanent disability (shown in Figure 6 and described in Table 2). Disability risk among soldiers with less than a college education increased by 6% with each increasing year ($p < .001$), while the risk among college-educated soldiers increased by only 4% with each increasing year ($p < .01$).

In addition to changes in the demographic profile of soldiers experiencing disability, there have been changes in the nature of disability among high-risk subgroups. Musculoskeletal-related disability is the fastest growing category of disability, increasing from 70 per 100,000 in 1981 to 950 per 100,000 by 2005 (data not shown). While increases in musculoskeletal disabilities have been experienced by both male and female soldiers, the growing disability burden experienced by women appears to be primarily attributable to musculoskeletal disability (Figure 7). Similar patterns appear for the association between college education and disability and white race and disability. That is, the

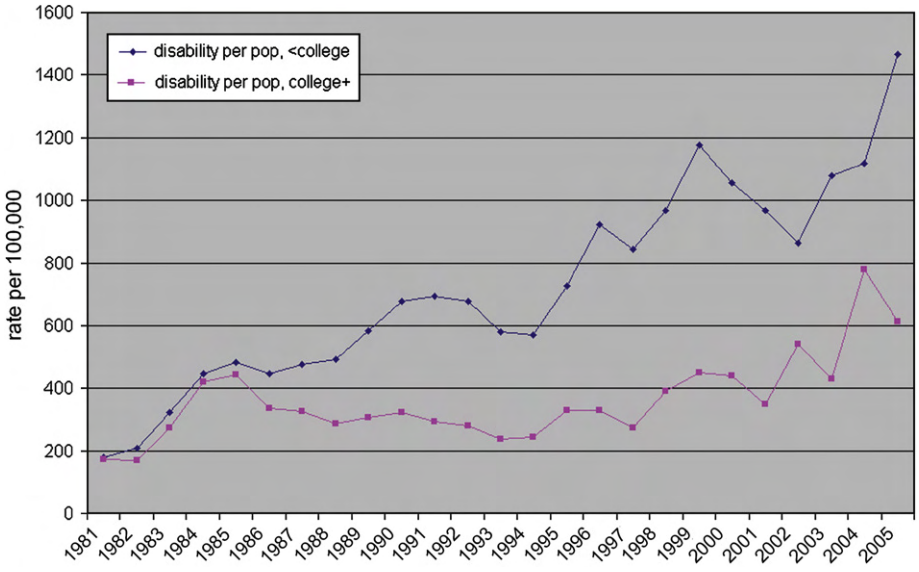

Figure 6. Education-specific disability risks per 100,000 population, 1981-2005.

Table 2
Time Series Estimates for Trend Analysis of Demographic Factors on Disability Discharge (Log Transformed) Among Soldiers for 1981-2005

	Variable	Estimate	S.R.	*t*	*p*	Durbin-Watson	Bera-Jacque	Total R^2
Female gender	Year	0.0853	0.0097	8.75	<.001	1.60^{NS}	0.11^{NS}	0.93
	AR(1)	−0.5585	0.1747	−3.20	<.004			
Male gender	Year	0.0529	0.0051	10.36	<.001	1.64^{NS}	2.78^{NS}	0.94
	AR(1)	−1.0456	0.1676	−6.24	<.001			
	AR(2)	−0.7341	0.1376	5.33	<.001			
Age, y								
35 or younger	Year	0.0715	0.0054	13.20	<.001	1.61^{NS}	1.55^{NS}	0.96
	AR(1)	−0.9975	0.1765	−5.65	<.001			
	AR(2)	0.6528	0.1568	4.16	<.004			
36 or older	Year	−0.0076	0.0112	−0.68	NS	1.89^{NS}	0.07^{NS}	0.66
	AR(1)	−1.1118	0.1935	−5.75	<.001			
	AR(2)	0.5515	0.1835	3.01	<.05			
Time in service								
<2 years	Year	0.0649	0.0076	8.56	<.001	1.99^{NS}	1.00^{NS}	0.96
	AR(1)	−1.0409	0.2006	−5.19	<.001			
	AR(2)	0.3868	0.1995	1.94	<.001			
2-10 years	Year	0.0813	0.0065	12.49	<.001	1.61^{NS}	4.70^{NS}	0.96
	AR(1)	−0.9975	0.1821	−5.48	<.001			
	AR(2)	0.6273	0.1633	3.84	<.001			
Service grade								
E1-E4	Year	0.0827	0.0061	13.60	<.001	1.67^{NS}	0.73^{NS}	0.97
	AR(1)	−1.0672	0.1840	−5.80	<.001			
	AR(2)	0.5583	0.1768	3.16	<.005			
E5-E6	Year	0.0427	0.0069	6.20	<.001	1.72^{NS}	5.07^{NS}	0.86
	AR(1)	−1.0154	0.1703	−5.96	<.001			
	AR(2)	0.7640	0.1291	5.92	<.001			
E7-E9	Year	−0.0320	0.0129	−2.47	<.022	1.87^{NS}	0.27^{NS}	0.71
	AR(1)	−0.8824	0.2251	−3.92	<.001			
	AR(2)	0.3955	0.2114	1.87	<.075			
Officers	Year	0.0258	0.0109	2.37	<.027	1.78^{NS}	0.80^{NS}	0.55
	AR(1)	−0.5735	0.1757	−3.26	<.004			
College								
None	Year	0.0658	0.0068	9.65	<.001	1.89^{NS}	3.41^{NS}	0.94
	AR(1)	−1.0417	0.1993	−5.50	<.001			
	AR(2)	0.6131	0.1736	3.53	<.002			
Yes	Year	0.0367	0.0120	3.06	<.006	1.90^{NS}	1.02^{NS}	0.61
	AR(1)	−0.5309	0.1806	−2.94	<.008			

NS, not significant; Durbin-Watson, test for presence of autocorrelation; Bera-Jacques, test for presence of heteroscedasticity.

major type of disability driving the variation in risk between those with and those without a college education appears to be musculoskeletal disorder and the risk of musculoskeletal-related disability is increasing more rapidly among white soldiers, followed by black soldiers (data not shown). The pattern is only partially consistent for younger soldiers compared to soldiers over age 35. As with the other high-risk demographic subgroups, musculoskeletal disability risks are increasing for both age groups, but the risk for disability is increasing most rapidly for those aged 35 or less. The pattern differs for age comparisons regarding ''other'' causes of disability. For other high-risk demographic subgroups (women, non–college educated), there are relatively little differences in patterns of risk for nonmusculoskeletal disorders. In contrast, for those aged 35 or less, there is a notable increased risk for nonmusculoskeletal disorders while risk of nonmusculoskeletal disorder disability among those over age 35 is decreasing (data not shown).

Discussion

Disability discharge risks are 7 times higher today than they were 25 years ago. The increase appears primarily attributable to disorders of the musculoskeletal system. Preliminary findings (in unadjusted models) indicate that rates of musculoskeletal-related disability are increasing faster than any other type of disability and the increase is occurring more rapidly among women, whites, blacks, those without a college education, and soldiers aged 35 or younger.

Multiple factors may influence an individual's likelihood of disability discharge. While the primary influence is a medical condition inconsistent with productive service, a number of administrative, social, and Army cultural factors may also be important. For these reasons, changes in the risk for discharge with a disability must be interpreted with caution. Whether increases in disability discharges are directly related to an increase in injury and illness,

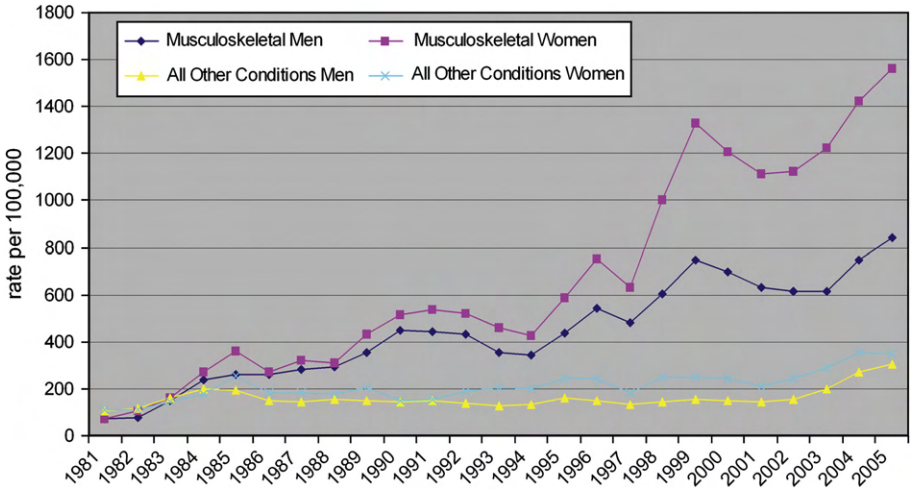

Figure 7. Musculoskeletal versus all other causes of disability (1981-2005) by gender: risks per 100,000 gender-specific population denominators.

earlier or more effective detection of these conditions by the Army medical system, a decrease in the Army's tolerance for retaining disabled individuals in the service, or an increase in individual propensity to seek evaluation or compensation cannot be directly determined from this preliminary review of the discharge data. In addition, the association between age and disability and tenure and disability should also be interpreted with caution as eligibility for disability benefits is partially dependent upon tenure. Soldiers with very short time on active duty (e.g., 2 years or less) may not be eligible for disability benefits and thus may not seek evaluation upon leaving the service with a disability. Thus, the real relationship between time in service (and, indirectly, age) and disability cannot be fully evaluated without placing it in the context of eligibility for benefits and, possibly, related motivation to seek disability evaluation upon discharge from the Army.

Assessing the association between demographic risk factors and disability is complicated by changes in the overall Army demographic profile as well as by shifts in the disability risk profile over the study period. The underlying Army population demographics shifted toward greater proportions of female, older, and Hispanic soldiers and greater representation among officers with concurrent reductions in the relative proportions of enlisted soldiers. In addition, the overall size of the Army has dropped by nearly 40% over the study period. Shifts in the proportion of soldiers by rank suggest that much of this reduction has occurred within the enlisted ranks. Given the growing risk of disability among enlisted, particularly younger or junior enlisted, it is possible that military downsizing, concurrent with multiple deployments and other occupational stressors, may be contributing to the increasing risk for disability within this demographic subgroup. Enlisted soldiers comprise an occupational cohort that needs further study in order to fully evaluate the etiology of this increased risk for disability.

Although the Army has become more female and disability risk is greater among female soldiers, adjusting for demographic changes, including greater representation of women and older soldiers with relatively fewer black, but more Hispanic, soldiers does not explain the increased risk for disability in the overall Army population. The lack of impact made by adjustment is due to the differences in the direction the adjustment shifts the risks. The overall percentage of women in the Army at large has increased *and* the disability risk among women per population of women has increased. In contrast, the average age of those with disability has decreased at the same time as the average age of the Army at large has increased. Similarly, disability risk among white soldiers has increased slightly as the relative proportion of white soldiers has slightly declined.

More research is needed to understand the etiology of the shift in the profile of soldiers experiencing permanent disability. It is not clear, for example, why risks for particular categories or types of disability among high-risk demographic groups have changed. It is not clear why certain demographic subgroups, notably women, younger soldiers, enlisted soldiers, and less educated soldiers, have more rapidly escalating disability risks.

The apparent protective effect of college education is worth further exploration. It is unclear whether this is related to a reduction in occupational exposures to certain risks, which might correspond to different job opportunities available to soldiers with a college degree, or whether it is more directly protective by improving resiliency or resistance to stress and/or improved self-care, which might result in reduced risk for long-term disability. In addition, because this is a descriptive study and results are not adjusted for other factors, the protective effect of a college education, higher rank, and, to some degree, older age is likely interrelated, making it difficult to parse out the unique contribution of the college degree alone.

Those over the age of 35 have seen a dramatic decline in their risk for disability. In addition, soldiers who remain on active duty and who avoid serious injury or disease for

15 years appear likely to remain disability-free by the time they retire. This relative improvement in the health and well-being of older soldiers with longer tenure may reflect a healthy worker or ''survivor'' bias. Or, it could be due to changes in medical care and screening that have resulted in a reduced overall risk for cardiovascular diseases.

Conclusion

Little research has been published describing the soldiers who leave the U.S. Army with a permanent disability. Even less is known about the underlying causes of these disabilities. Yet, risk for disability is increasing rapidly, resulting in huge economic losses to the U.S. government and, ultimately, the taxpayer. In addition, and more importantly, by 2005 more than 7,000 people with life-altering disabilities were being discharged from the Army, even before the full impact of conditions related to deployment in support of Operation Iraqi Freedom had a chance to work through the system.

This is only a fraction of the problem as it does not include soldiers who have disabling conditions but nonetheless seek evaluation and treatment for their conditions in the VA or through other health care systems only after their discharge from the Army (as it is their right to do). There is currently no mechanism in place to link DoD and VA data resulting in a discontinuity of service over time and an inability to explore individual-level health care data longitudinally. To fully enumerate and understand disability morbidity, it will be necessary to examine disability compensation data from the Veterans Benefits Administration branch of the VA linked to Army discharge data. Ideally, soldiers seeking care outside of either the VA or DoD compensation programs should also be identified and followed. Because the Army only discharges individuals with conditions that preclude active service while the VA also provides compensation for functional limitations caused or aggravated by military service, *both* systems need to be evaluated in order to fully appreciate the magnitude and characteristics of service-connected disability. Preliminary studies that have been able to link VA disability data, for Army soldiers who seek evaluation in the VA, with the Army disability data result in a 3-fold increase in disability case ascertainment (S. Sulsky, personal communication, 2007).

There have been recent concerns over the actual treatment received by disabled veterans, the process for receipt of benefits and compensation, as well as various calls for improved data exchange between 2 agencies. Proposed changes in how disability is managed by the government may make it easier in the future to enumerate the total impact of disability [29,30].

Results from these analyses suggest that changes in the underlying Army population demographics over time do not explain the overall increased risk in disability. While increases in disability risk are generally being experienced across all military demographic groups, the subgroups with the fastest growing risks are women and junior enlisted and younger soldiers. The primary cause of these disabilities appears to be injury or the adverse effects of acute and chronic injury and related musculoskeletal conditions. While more research is needed to understand the underlying causes of these conditions, the changing profile of disability suggests that key demographic groups to focus on include women, younger soldiers, junior- or mid-level enlisted soldiers, and those with less than a college education.

Future research should include multivariate predictive models to assess the independent effect of gender, education, rank, and age, while controlling for changing temporal patterns (e.g., increasing risk among women over time, decreasing risk among older soldiers, increasing protective effect of college education) and accommodating potential interactions between risk factors (e.g., gender and age interactions) [16]. Future analyses should explore variations in risk factors for different types of disability overall and within high-risk subgroups. Models will need to control for variations in disability eligibility (e.g., time in service). Ultimately, results from this and future research efforts should be used to inform interventions with well-conceived evaluation plans in order to assess effectiveness in reducing the burden of disability.

Acknowledgments

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Appendix C

Temporal changes in the nature of disability: U.S. Army soldiers discharged with disability, 1981--2005

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Abstract

Objectives: (1) document and describe the relative proportion of disabilities by major type over the study period; (2) describe the population at risk for different types of disability; and (3) document and describe the type of compensation (an indicator of severity) awarded for different types of disability and any temporal changes in these associations.

Methods: Time-series, logistic regression analyses and direct standardization of rates were used to study 108,119 active-duty Army soldiers discharged with permanent disability between 1981 and 2005.

Results: 91% percent of all disability is captured within the top five most prevalent types of disability: musculoskeletal (72%, N=77,418) neurological (6%, N=6,896), mental health (5%, N=5,075), cardiovascular system (4%, N=4,429) and respiratory (4%, N=4,202). Musculoskeletal disability rates are increasing rapidly (+2.5% per year); neurological and cardiovascular disability rates are decreasing (-1.3% and -10.0% annually, respectively), and respiratory and mental health disability rates did not change significantly. Demographic risk factors vary by disability type. At greatest risk for musculoskeletal disability were female soldiers, soldiers who were between the ages of 21-35, white, in lower- to mid-level enlisted ranks with relatively short service tenure, and soldiers without a college education. Compensation awards also varied by disability type: Overall, 77% (N=83,320) received separation with severance pay, 15% (N=16,107) received a permanent disability retirement and 8% (N=8,692) received separation without benefits. Separation with severance pay was the largest and fastest growing disability disposition for all disabilities and for musculoskeletal disability specifically.

Conclusions: Demographic risk factors vary by type of disability and by compensation award. Musculoskeletal disability rates are rapidly increasing as is separation with severance pay--particularly among white, young, lower ranking and female soldiers.

Key words: disability, U.S. Army, risk factors, musculoskeletal, compensation, demographic, trends, TAIHOD

Introduction

The economic and personal costs of disability are substantial and growing in both civilian and military populations. Within the U.S. Army, the rate of disability discharges has increased nearly 10% per year over the past three decades. These increases are not explained by changes in the demographic composition of the Army over this same time period (1).

Disability is costly both in terms of direct payment for medical expenses and the payment of long-term disability-related compensation. In addition, it impacts productivity and combat readiness. The U.S. Army's downsizing efforts of the 1990s (2, 3) combined with varying levels of recruitment success over the past few years and the overall strain on soldiers with lengthy deployments and redeployments (4, 5 2007) have resulted in fewer active-duty personnel to complete ever more demanding military missions. Maintaining sufficient manpower is therefore critical. Reduced troop force is compounded by the many injuries and disabilities sustained in recent years. Thus, the rapidly escalating disability risks, particularly during a time of increased occupational exposures to injury related to the war in Iraq, are worrisome.

Neither the nature nor the etiology of the increasing disability risk is well documented or understood. Only a limited number of disabling conditions have been studied. The few research studies published that address factors associated with discharge for medical disability in the US Army have focused upon a few specific types of musculoskeletal disabilities (6-12) or, to a lesser extent, select psychiatric disorders (13), or outcomes of psychological disorders, such as suicide.

It is not clear whether overall increases in disability are occurring for all types of disability or if the increases are primarily attributable to specific types or causes of injuries or diseases. In addition, published research to date has not focused on variations in risk factors for different types of disability among Army soldiers. Our most recent work demonstrated that the increasing burden of disability in the Army overall was being borne predominantly by women, younger and lower ranking soldiers, and those with less than a college education and with between 2 and 10 years of active service (1). But, these patterns may vary by type of disability. In addition, because the demographic characteristics of the Army have shifted over the past few decades and demographic factors, such as gender, are associated with different disability risk patterns (6, 7, 10, 14), it is important to clarify whether changes in the demographic characteristics of Army soldiers have resulted in changes in the relative proportions of different types of disabilities.

It is also unclear if the overall increase in disability represents an increase in all levels of severity or if the increase is occurring disproportionately among either the more severe or the more mild disability cases. Changes in occupational exposures related to increased deployments or other occupational demands may

result in an increase in severe injury. On the other hand, changes in medical practice and management of various conditions as well as improvements in combat-protective gear may result in improved outcomes and thus tilt the balance toward less severe disability. In order to fully evaluate and assess the growing disability problem it is important to understand not only which types of disabilities are increasing and which demographic groups are most affected but also to assess how serious or severe the growing number of disability cases are.

A number of factors may be associated with disability-related separation from the Army. An improved understanding of causes and risk factors for different types of disabilities would have great utility for targeting high-risk populations and developing appropriate preventive interventions. Awareness of these factors has been limited, however, for several reasons. The relative contributions of various risk factors are largely unknown due to a paucity of studies that have investigated this issue using multivariate methods. Current information collected by the military disability system focuses on the residual problems of the disabling condition, shedding little light on the underlying, potentially preventable causes (15). While some research has evaluated demographic, occupational and health characteristics of soldiers discharged with a medical disability, most research on factors leading to a medical discharge has been restricted to new recruits, a problem noted by several authors (6-8, 16).

The objectives of this study are to (1) document and describe the relative proportion of disabilities by major type over the study period; (2) describe the population at risk for different types of disability; and (3) document and describe the type of compensation (an indicator of severity) awarded for different types of disability and any temporal changes in these associations.

Methods

***Data sources*.** Data come from the Total Army Injury and Health Outcomes Databases (TAIHOD), a compilation of files containing demographic and health information on active-duty Army personnel that can be linked through individual identifiers (17, 18). This paper included TAIHOD data from personnel records (demographic and discharge information) from the Defense Manpower Data Center (DMDC) and Disability records from the U.S. Army Physical Disability Agency (19).

Study Population. The study population comprised all active-duty Army soldiers discharged with permanent disability between 1981 and 2005 (N=108,119).

Measures. All disabilities are rated according to the Veterans Administration Schedule for Rating Disabilities (VASRD) which essentially describes functional limitations. Thus VASRD codes are not true clinical diagnoses. However, a recent study linking a subset of disability cases to clinical records suggests that

the primary VASRD codes for a given disability represent underlying clinical conditions consistent with the category topic (20).

The VASRD system is organized into 16 body organ/system groups. However, due to the relatively small number of "other" sensory organ disability cases, we collapsed disabilities related to the ear with disabilities of "other sense organs" (excluding conditions occurring to the eye) yielding a total of 15 broad VASRD groups for analysis purposes: musculoskeletal conditions; neurological conditions; mental health disorders; cardiovascular conditions; respiratory conditions; endocrine disorders; digestive conditions; diseases of the eye; skin disorders; genitourinary conditions; infectious diseases, immune disorders, and nutritional disease; hemic and lymphatic disorders; diseases of the ear and other sensory organs; gynecological conditions; and, dental and oral conditions. Each disability discharge is coded with up to four VASRD codes in the Army database. Cases were selected and categorized for these analyses based only on the primary (first) VASRD code.

Ninety-one percent of all disability discharges fall into five of the 15 VASRD groups; These are: (1) the **musculoskeletal system,** which includes diseases of, and injuries to, the musculoskeletal system, as well as amputations and prostheses, (2) the **neurological system,** including disorders of the central nervous system, cranial nerves, peripheral nerves, epilepsies, and miscellaneous diseases (e.g., migraine), (3) **mental disorders,** which include schizophrenia and other psychotic disorders, delirium, dementia, amnestic and other cognitive disorders, anxiety disorders, and mood disorders, (4) the **cardiovascular system** including the heart, arteries and veins and (5) the **respiratory system** including the trachea, bronchi and non-tuberculosis lung and pleura. All other disability subgroups account for 2% or less of the total disability cases.

In addition to VASRD codes describing the nature of the disability, the disability data also include a final disposition indicating the percentage of disability and award received. Only cases with a final disposition of "permanent disability" were included in these analyses. Soldiers placed on the Temporary Duty Retirement List (TDRL) while awaiting stabilization of their condition(s) were excluded. Soldiers with a permanent disability status may, or may not, be eligible to receive compensation. Eligibility depends upon length of Army service and a determination about whether the conditions were caused by or aggravated by active duty. Permanent disability benefits options include (a) separation without benefits (for soldiers with less than 8 years of active service and/or a noncompensable disability); (b) separation with severance pay (lump sum); and (c) retirement with permanent disability status (eligible to receive benefits over one's lifetime with amount dependent upon percentage of disability rating). More details describing the disability rating system may be found in 10 U.S. Code, Ch. 61 (21).

Demographic covariates came from the DMDC personnel files and included gender, age, race, marital status, education, rank, and time in service. The TAIHOD personnel files are updated every six months. The DMDC file closest to the date of disability status determination was used for this analysis. The DMDC six-month files were also used to identify total population counts for the computation of rates per 100,000 population.

Data Analysis

Initial analyses included exploration of frequency distributions and analysis of rates for each major category of disability among U.S. soldiers discharged from the Army with a permanent disability during the years 1981 through 2005. Multiple logistic regression analysis was used to assess associations between demographic characteristics and each of the top VASRD categories among soldiers discharged with a disability. Demographic covariates included in the models were: gender (female as referent); ages 21-25, 26-30, 31-35, 36-40, greater than 40 (with less than 21 years as referent); race/ethnicity (black, Hispanic, other (white as referent); single and previously married (married as referent); military rank (with E1-E4 as referent); and time in service years (as a continuous variable). Risk for a particular disability type was compared to risk for the other four types of disability in the model and for a particular type of benefit relative to all other types of benefit. Logistic regression models compared associations between demographic categories and each type of disability compensation award.

A visual display was created to contrast the unadjusted and adjusted disability discharge rates by cause of disability. Covariates selected for these adjusted rate figures were based on changes over time in the total active-duty Army population demographics (1). The continuous covariate age was first dichotomized after examining frequency distributions of standard categories of the variable over the study years. The category that showed the most change over time was then used as the referent category for the chi-squared analyses. The referent categories for these variables were as follows: age <21 years vs. >=21 years; education high school or less vs. some college or greater; race/ethnicity (a) white vs. non-white; (b) black vs. non-black; (c) Hispanic vs. non-Hispanic. We did not include education as a covariate for the visual display because the magnitude of the statistic was substantially lower for this variable as compared to the other demographic variables. We did include the various race-ethnicity groupings in early versions of the Direct Standardization grouping but found the adjusted trendline was not changed by the inclusion of other racial-ethnic category comparisons and thus included only white vs. non-white in the final figure. The Direct Standardization method adjusts the rates for subsequent years by the total of expected cases in the “standard” population of active-duty soldiers, which in our case, was drawn from 1981, the first year of our follow-up with a full year of data. (22).

Autoregressive time series analytic models were used to assess temporal changes in the disability discharge rates by cause of disability for the years 1981 through 2005. In time series data, error terms may be serially correlated yielding bias in ordinary regression models. Autoregressive models correct for the autocorrelation between data in a related series (i.e., years 1982 through 2005). Stepwise autocorrelation selects the order of the autoregressive error model (i.e., AR1, first-order autocorrelations that adjust for the prior one year, AR2, second-order autocorrelations that adjust for two years prior). The Durbin-Watson test is used to test for the presence of autocorrelation; when it is not significant, the model has effectively reduced the bias due to autocorrelation. The ARCHTEST disturbances (i.e., Q statistics test and Lagrange Multiplier test) are used to test for heteroscedasticity of error variance (23). When these statistics are not significant, the error variance is considered homoscedastic. Unless otherwise indicated, all models passed tests indicating that the adjustments had corrected any autocorrelation and heteroscedasticity. In separate analyses, rates of permanent disability per 100,000 population for specific demographic groups were regressed on years of study period (1981-2005). Log transformation was applied and temporal estimates from the autoregressive models are interpreted in terms of percent change by taking the exponent of the obtained estimate.

Analyses were conducted using SAS versions 8.2 and 9 (SAS Institute, Cary, NC). All analyses for this project adhere to the policies for the protection of human subjects as prescribed in Army Regulation 70-25, and with the provisions of 45 CFR 46.

Results

There were 108,119 soldiers discharged from the Army with a permanent disability between 1981 and 2005. In our earlier work we describe the demographic composition of this population (1). Musculoskeletal disorders (injury and disease) were the leading cause of disability over the study period comprising 72% of cases overall. In addition, the relative proportion of the total disability cases attributable to musculoskeletal disorders increased from 64% of the total for the first half of the study period to 78% of the total cases during the latter half (see Figure 1).

{INSERT FIGURE 1 about HERE}

Ninety-one percent of all disability is captured within the top five most prevalent disability categories. These were: musculoskeletal problems (72%, N= 77,418) neurological conditions (6%, N= 6,896), mental health disorders (5%, N= 5,075), cardiovascular system conditions (4%, N= 4,429) and respiratory problems (4%, N= 4,202) (see Figure 1). The remaining findings are focused on these top five disabling conditions.

Autoregressive models yielded statistically significant temporal patterns for musculoskeletal (estimate = 0.025, S.R. = 0.009, t = 2.59, < .02, Durbin-Watson = 1.95, not significant), neurological (estimate = -0.013, S.R. = 0.006, t = -2.00, p<.05, Durbin-Watson = 1.96, not significant) and cardiovascular (estimate = -0.10, S.R. = 0.01, t= 8.29, p<.001, Durbin-Watson = 1.78, not significant) disability discharge rates. There were no significant temporal patterns for respiratory and mental disorders. The musculoskeletal system disability rate increased by 2.5% with each successive year, while the rates for neurological and cardiovascular systems decreased by 1.3% and 10% with each successive year, respectively.

Variations in demographic factors associated with each major type of disability are shown in Table 1. It is important to note that the analysis of demographic factors for each type of disability discharge is relative to other causes of disability discharge. Thus, an OR<1 for say, male gender, means that other disability discharge causes must have an OR >1. It would not necessarily mean that male gender per se is not a risk factor for a particular disability outcome but rather that it is simply less of a risk factor for that outcome relative to its association with the other selected types of disabilities.

Results from multivariate logistic regression models (Table 1) indicate that male soldiers were relatively less likely than female soldiers to be discharged with musculoskeletal or respiratory conditions but were relatively more likely to be discharged with neurological and mental health disorders. In general, younger disabled soldiers were relatively more likely to be discharged with disability related to musculoskeletal disorders and respiratory conditions while mental health disorders and cardiovascular conditions were generally more common among older soldiers discharged with disability. With regard to race/ethnicity, white soldiers were at greater risk for musculoskeletal and neurological disorders. Black soldiers were at greater risk for respiratory conditions and cardiovascular disorders (versus white soldiers). Hispanics were at greater risk relative to white soldiers for respiratory conditions. “Other” racial ethnic groups (non-white, non-black, and non-Hispanic) racial/ethnic groups were at greatest risk for mental health disability. Marriage was associated with increased risk for musculoskeletal disorders and respiratory conditions, but protective for mental health disorders. Having a high school degree or less (versus some college or a college degree) was associated with increased risk for musculoskeletal disorder and mental health disability but lower odds of cardiovascular disability. Lower rank was associated with increased risk for musculoskeletal disability, but lower risk for cardiovascular disability and mental health disability. Shorter total time on active duty was related to increased odds per year of active duty for musculoskeletal or mental health disability but lower odds per year for respiratory, cardiovascular, and neurological disability.

{INSERT TABLE 1 APROXIMATELY HERE}

Over the study period, the proportion of women and officers in the Army increased while the proportion of lower ranking enlisted soldiers decreased; The proportion of Black soldiers decreased while those of Hispanic descent increased(1). In order to assess whether these demographic shifts may explain increasing rates of musculoskeletal disability, annual musculoskeletal disability rates were adjusted for gender, age and race (see Figure 2). The Cochran-Armitage Trend test statistic was -328.6, -250.1, and -23.6, for age, gender, and education, respectively; $p<0.0001$ in all comparisons. For the race/ethnicity groupings, the Cochran-Armitage Trend test was 164.9, 124, and -386.6, respectively; $p<0.0001$ in all comparisons. However, as noted in the visual display, the adjustment to disability rates for these changes in the demographic composition of the Army over time made little difference in the trajectory of annual disability rates.

{INSERT FIGURE 2 APROXIMATELY HERE}

Most soldiers who were discharged with a permanent disability received separation with severance pay (77%, N=83,320). Fifteen percent (N=16,107) received a permanent disability retirement; and 8% (N=8,692) received separation without benefits. Separation with severance pay was the largest and fastest growing disability disposition. Results from the autoregressive models exploring temporal changes in the benefits awarded to soldiers with disability indicate that with each increasing year permanent disability retirement decreased by 10% and separation with severance pay increased by 3%.

Disability discharge with severance pay was also the most common compensation award associated with musculoskeletal disability (Table 2). Mental disorders and respiratory disorder disabilities were over-represented among disability discharges with no benefits. Cardiovascular disorders were overrepresented among those retired with a permanent disability discharge. Neurological conditions were overrepresented among both those disability discharges receiving no benefits and those with a permanent disability discharge.

{INSERT TABLE 2 APPROXIMATELY HERE}

Table 3 shows results from logistic regression models comparing demographic factors for each type of disability disposition. Risk factors for the most rapidly growing disability outcome group, separation with pay, include: female gender, age 21-40, white race, separated/divorced, less than a college education, and lower enlisted rank.

Men are more likely than women to receive the highest compensation package of permanent disability retirement or the lowest compensation of separation without benefits. Female soldiers with a disability are most likely to receive the middle-level compensation package: separation with benefits.

Up until age 35, there was an increasing likelihood of separation with severance pay with increasing age. Individuals with more time-in-service were more likely to receive permanent disability benefits with those over age 40 most likely to receive permanent retirement. With regard to race/ethnicity: black soldiers and soldiers in the "other" racial/ethnic category are significantly more likely to receive either permanent retirement or to be separated without benefits versus separation with severance pay. Single soldiers are significantly more likely than married soldiers to receive permanent retirement OR separation without benefits than they are severance pay. Separated/divorced and widowed soldiers are significantly more likely than married soldiers to receive separation with severance pay and significantly less likely to receive permanent retirement.

College degree is associated with increased likelihood of both separation without benefits and permanent retirement (compared to those with a high school degree or less). The pattern was not consistent for those with some college educational courses but who had not completed a degree. Soldiers with "some college education" are more likely to be discharged with a permanent retirement benefit but significantly less likely to be separated with severance pay than soldiers with just high school degrees. In general, higher rank is associated with less likelihood of separation without benefits and greater likelihood of permanent disability. Longer time in service is associated with a greater likelihood of receiving permanent retirement and lower likelihood of receiving separation with or without pay.

{INSERT TABLE 3 APPROXIMATELY HERE}

Limitations

The finding that older soldiers are at lower risk of musculoskeletal disorders may reflect a survivor bias or healthy worker effect. These findings should thus be interpreted with caution. Assessment of the factors associated with disability disposition should also be interpreted with care. Severity of the condition and total time on active duty both contribute to the final assessment of disability disposition and compensation award. They cannot be completely untangled. The multivariate models do include a variable indicating total time in active service so in theory most of the variation remaining should be due to severity. However, the process for assessment is complex and somewhat subjective. Thus, disability compensation is not a perfect indicator of severity. In addition, the exclusion of soldiers awaiting final review and decision about possible disability (temporary disability assignment) will result in a slightly smaller disability population in the later years of the study. When these temporary cases are resolved, the final disability population for later years we estimate that the number of disability cases could be as much as 15% greater (19). Finally, it is important to note that associations between demographic factors and disability are descriptive and should not be viewed as causative.

Conclusion

Disability is an enormous and costly challenge for the armed forces. In fiscal year 2005 alone the Department of Defense paid disability-retired military service members $1.25 billion, $474 million of which was for disabled Army retirees (24). Moreover, the problem is growing at an alarming rate such that by 2005 more than 7,000 people with life-altering disabilities were discharged from the Army (1). This represents an increase of 600% between 1981 and 2005 (1). Since the process of treatment, rehabilitation and evaluation may cause delays of up to several years between onset of a condition and disability discharge, conditions related to deployment in support of Operation Iraqi Freedom are not yet fully reflected in these disability figures. Thus, it seems likely that costs will continue to increase as individuals with war-related disabilities are fully processed. Currently pending, and recently approved, legislation (such as Public Law 108-136, sections 641 and 642) designed to eliminate concurrent receipt limitations on retirement pay and disability compensation, will likely cause further acceleration of the direct cost of service connected disability.

The problem is largely attributable to musculoskeletal system disorders. Musculoskeletal disability comprised the largest category of disability over the nearly 25 year study period. In addition, as a relative proportion of the total disability, it is the only category of disability that demonstrated consistent, statistically significant *increasing* trends. In contrast, disability related to cardiovascular disease, a primary contributor of disability among older soldiers in the past, and neurological disorders have declined over time.

The demographic groups at greatest risk for musculoskeletal disability were soldiers who were female, between the ages of 21-35, white, lower to mid-level enlisted rank soldiers and those with relatively short time in service and who had attained a high school degree or less. The past 15 years have witnessed substantial changes in the demographic constitution of the U.S. Army, most notably for age, gender and race/ethnicity. There are more female soldiers, more Hispanics, fewer Blacks, and fewer very young (i.e., <21 years of age) soldiers. However, our investigation revealed that these demographic changes in Army composition do not explain increases in musculoskeletal-related disability discharge. In addition, the direction of some of these associations is consistent with that reported in other studies. For example, other studies have also found that white soldiers are at greater risk than black soldiers for musculoskeletal disorders (25-28).

Disability has increased across all demographic groups but has been growing most rapidly among certain subgroups. This is particularly true for musculoskeletal disorders. Surveillance efforts and future research should focus on clarifying the etiology of this increasing risk and on the development of targeted intervention strategies. One might ask, for example, whether different subgroups (e.g., males vs. females, soldiers 21-35 years of age vs. older soldiers) are discharged with different types of musculoskeletal disorders or

whether there are other important differences in the patterns of injury that may reveal unique etiologies (e.g., knee versus back injury; evidence of acute trauma versus overuse, variations by occupational exposures). Certainly the fact that enlisted soldiers are at greater risk than officers probably reflects in large part occupational differences in exposures to risk factors.

Future research might also examine the relationships between minority race/ethnicity and differential risk of VASRD causes, to understand what factors might explain, for example, the greater risk of musculoskeletal and neurological discharge among white soldiers or the higher risk of respiratory disability among Hispanics or mental health discharge for "other" race/ethnicity categories. A report by Bray et al. surveying health behaviors among active-duty military service members (29) documented that minorities were less likely to report smoking in recent years, yet our findings show that their risk of respiratory disability discharge is higher. It would be useful to understand this relationship better. It is also important to note that while it is useful to explore risk factors for different broad groupings of disability, there is likely considerable heterogeneity even within these categories. For example, musculoskeletal disability includes both diseases of the musculoskeletal system, such as arthritis, and the late effects of acute injuries. While some of the risk factors may be similar for these different outcomes, there is likely variation across demographic groups in risk factors and exposures related to these different types of musculoskeletal problems.

As expected, time in service is strongly associated with the type of benefit package awarded: longest tenure is associated with a permanent retirement award, followed by separation with benefits. Shorter tenure was associated with increased likelihood of separation without benefits. Separation with a lump sum severance payment for disability is the fastest growing disability compensation category. Factors associated with this type of disposition included female gender, age 26-40, white race, separated/divorced, less than a college education, and lower enlisted rank and a disability related to musculoskeletal disorder.

Variations in compensation awards by demographic factors may simply reflect underlying demographic factors associated with the primary VASRD disability group: musculoskeletal conditions. Musculoskeletal conditions make up, by far, the largest disability group and the compensation package most commonly associated with these types of disabilities is separation with severance pay. Thus, demographic factors such as race or other factors may simply reflect differences in risk for musculoskeletal conditions. Black soldiers, and other minorities, were less likely to have a musculoskeletal injury and were also less likely to receive separation with severance pay (compared to permanent retirement and separation without pay). What is not clear from these analyses is whether these patterns reveal underlying variations in risk for certain occupational exposures and/or predisposition to particular outcomes. These

associations could result in some racial/ethnic groups being less likely to be injured and thus less likely to experience musculoskeletal disability (25).

The three compensation packages are awarded using a possibly antiquated system that takes into account both total Army tenure and severity of the underlying condition. Thus, the categories reflect, to some degree, varying levels of underlying severity of the condition. However, other factors likely are involved in the assignment of a compensation award. Therefore, even though there is an apparent order to the different compensation awards, the different award types may not consistently reflect an ordinal association with severity. For example, those with some college education but not a college degree were consistently more likely to receive permanent disability retirement versus either separation with a lump sum severance benefit or separation without benefits. But, having a college degree was only associated with permanent disability if compared to likelihood of separation with severance pay. College degree was associated with greater likelihood of separation with no benefits versus a permanent disability. Those with a college degree or a high school degree or less were most likely to experience separation with no benefits, while soldiers with some college were more likely to receive severance pay than separation with no severance pay. It is not clear why there are unexpected nonlinear associations between educational attainment and compensation award. Soldiers who have completed some college level courses are likely quite different from those with a college degree. They may face different occupational exposures, and thus different health risks leading to different patterns of disability. Inconsistencies across compensation packages provide evidence against an ordinal scaling of the compensation categories for analyses and support the use of the multinomial logistic regression approach used in this study.

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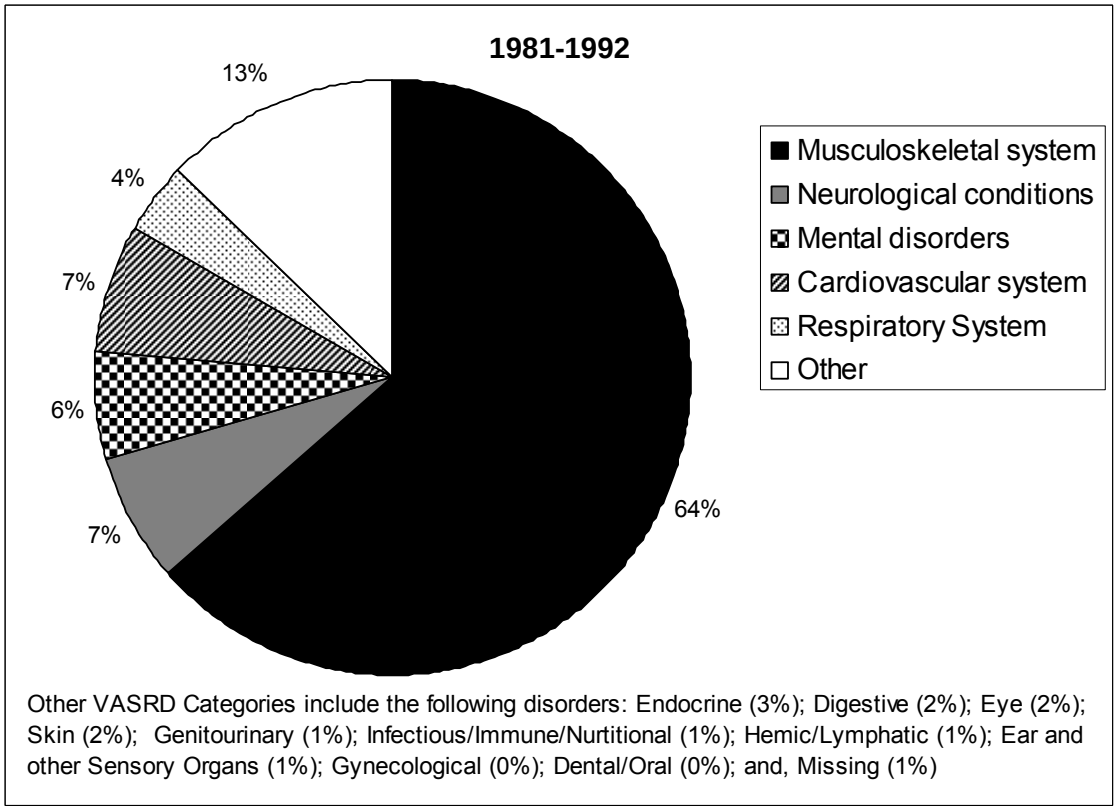
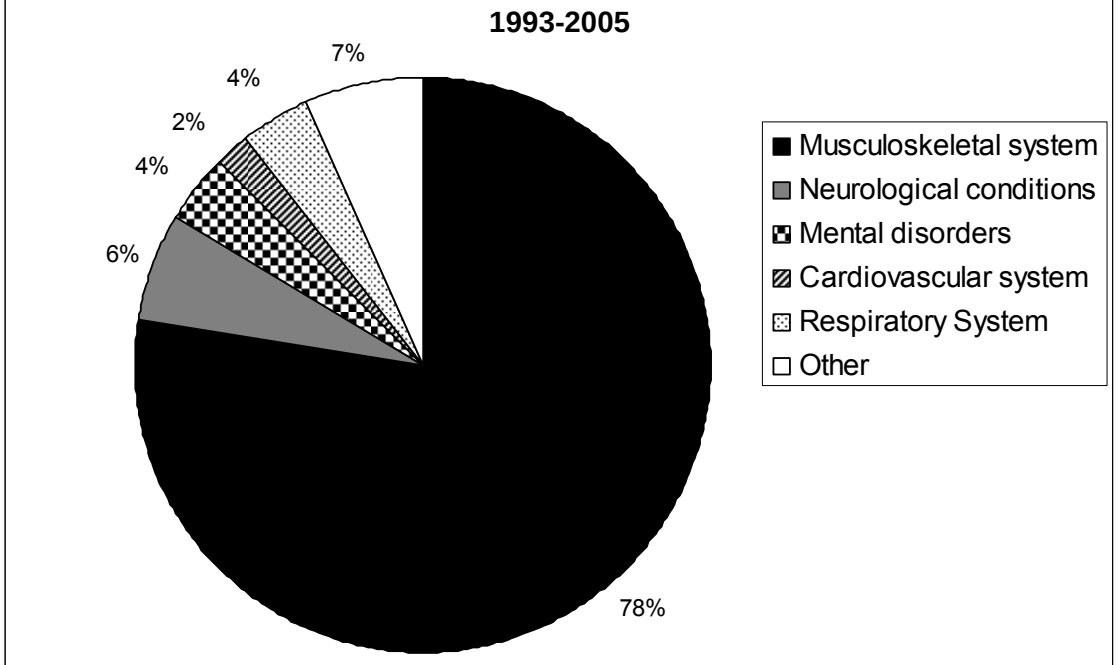
Figure legends:

Figure 1. Relative proportions of different types of disability by era: 1981-1992 compared to 1993-2005

Figure 2. Annual disability rates per 100,000 active-duty soldiers for musculoskeletal system disorders – crude rates and rates adjusted for gender, age and race/ethnicity (1981-2005)



Other VASRD Categories include the following disorders: Endocrine (3%); Digestive (2%); Eye (2%); Skin (2%); Genitourinary (1%); Infectious/Immune/Nurtitional (1%); Hemic/Lymphatic (1%); Ear and other Sensory Organs (1%); Gynecological (0%); Dental/Oral (0%); and, Missing (1%)



Other VASRD Categories include the following disorders: Endocrine (2%); Digestive (1%) Eye (1%); Skin (1%); Genitourinary (0%); Infectious/Immune/Nurtitional (0%); Hemic/Lymphatic (0%); Ear and other Sensory Organs (1%); Gynecological (0%); Dental/Oral (0%); and, Missing (0%)

Table 1. Summary of logistic regression models for selected VASRD categories by demographic status					
	Musculoskeletal OR (95% C.I.)	**Respiratory** OR (95% C.I.)	**Cardiovascular** OR (95% C.I.)	**Neurological** OR (95% C.I.)	**Mental Health** OR (95% C.I.)
Gender					
Male	0.86*(0.82-0.88)	0.82*(0.76-0.89)	1.01 (0.92-1.10)	1.24*(1.15-1.33)	1.31*(1.22-1.42)
Female (referent)	1.00	1.00	1.00	1.00	1.00
Age					
<21 (referent)	1.00	1.00	1.00	1.00	1.00
21-25	1.12*(1.07-1.17)	1.03 (0.92-1.16)	0.57*(0.51-0.64)	1.06 (0.92-1.14)	1.05 (0.96-1.15)
26-30	1.24*(1.17-1.31)	0.80*(0.70-0.92)	0.53*(0.46-0.61)	1.02 (0.92-1.13)	1.22*(1.09-1.37)
31-35	1.27*(1.19-1.36)	0.71*(0.61-0.84)	0.54*(0.46-0.64)	1.00 (0.88-1.13)	1.54*(1.35-1.76)
36-40	1.06 (0.97-1.15)	0.80+(0.66-0.97)	0.88 (0.74-1.06)	1.00 (0.86-1.17)	2.09*(1.76-2.47)
>40	0.76*(0.68-0.85)	0.91 (0.71-1.16)	1.55*(1.25-1.91)	0.98 (0.81-1.20)	2.37*(1.90-2.96)
Race/ethnicity					
White (referent)	1.00	1.00	1.00	1.00	1.00
Black	0.77*(0.75-0.80)	1.62*(1.51-1.74)	1.11*(1.03-1.19)	0.88*(0.83-0.94)	1.04 (0.97-1.12)
Hispanic	1.01 (0.94-1.07)	1.21*(1.05-1.41)	0.61*(0.51-0.74)	0.91 (0.80-1.02)	0.99 (0.86-1.13)
Other	0.97 (0.90-1.04)	1.07 (0.91-1.26)	0.79*(0.67-0.94)	0.92 (0.81-1.05)	1.24*(1.09-1.42)
Marital status					
Single	0.82*(0.80-0.85)	0.86*(0.80-0.93)	1.05 (0.96-1.14)	1.00 (0.94-1.06)	1.80*(1.68-1.93)
Married (referent)	1.00	1.00	1.00	1.00	1.00
Previously married	1.04 (0.97-1.12)	0.89 (0.76-1.05)	0.86 (0.73-1.01)	0.96 (0.84-1.10)	1.26*(1.08-1.46)
Education					
≤High school or equivalent (referent)	1.00	1.00	1.00	1.00	1.00
Some college	0.74*(0.70-0.79)	1.13 (0.99-1.29)	1.34*(1.21-1.50)	1.07 (0.96-1.19)	1.35*(1.20-1.52)
≥College degree	0.91*(0.85-0.98)	0.93 (0.77-1.11)	0.95 (0.82-1.11)	0.94 (0.82-1.08)	1.29*(1.12-1.48)
Rank					
E1-E4 (referent)	1.00	1.00	1.00	1.00	1.00
E5-E6	0.91*(0.87-0.95)	0.99 (0.90-1.09)	1.05 (0.94-1.17)	0.97 (0.90-1.05)	1.09 (0.99-1.21)
E7-E9	0.50*(0.46-0.55)	1.05 (0.87-1.28)	2.06*(1.76-2.43)	1.12 (0.96-1.31)	2.10*(1.72-2.56)

Officer	0.52*(0.47-0.57)	1.23 (0.97-1.55)	1.58*(1.28-1.94)	1.44*(1.21-1.71)	1.70*(1.41-2.04)
Time in service (in years)	0.97*(0.97-0.98)	1.03*(1.01-1.04)	1.04*(1.03-1.05)	1.02*(1.01-1.03)	0.93*(0.91-0.94)

* p < .01; + < .05.

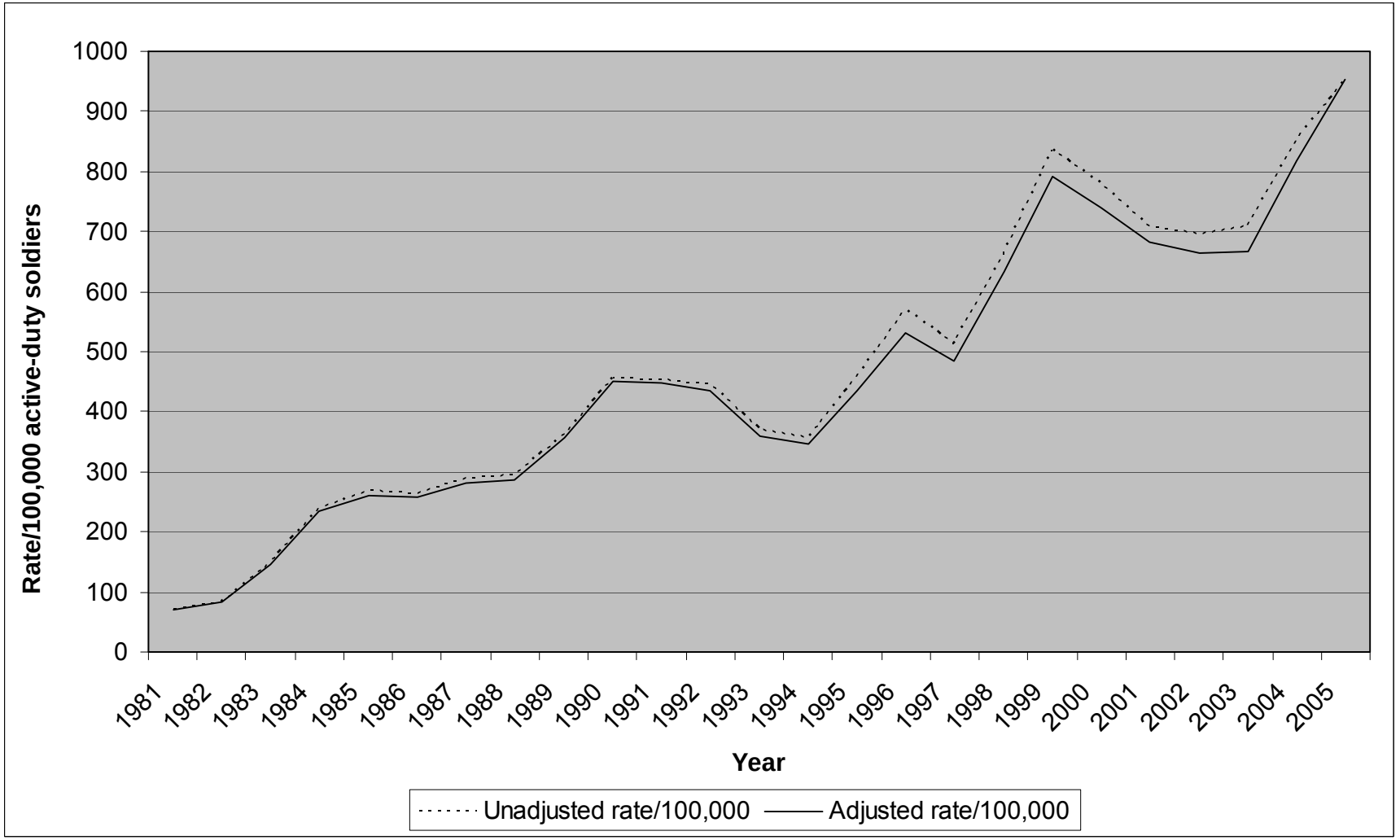

Rate/100,000 active-duty soldiers
1000
900
800
700
600
500
400
300
200
100
0
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Year
Unadjusted rate/100,000
Adjusted rate/100,000

Table 2. Association between type of disability and type of benefit awarded among soldiers discharged with a disability, 1981- 2005.

Major Causes of Disability Discharge (VASRD)	Separation without benefits	Separation with Severance Pay	Permanent Disability Retirement	Total
	N=8,692 %	N=83,320 %	N=16,107 %	N=108,119 %
Musculoskeletal system	50.52	79.93	39.92	71.62
Respiratory system	6.87	3.08	6.45	3.89
Cardiovascular system	2.80	2.50	13.06	4.10
Neurological conditions	9.19	5.14	11.25	6.38
Mental disorders	19.04	3.07	5.36	4.69

[a]Percentages shown only for top 5 most common VASRD categories

Table 3. Logistic regression: Demographic characteristics associated with type of benefit received among soldiers discharged with a disability from the Army between January 1981 and December 2005.

	Separation without benefits	**Separation with Severance Pay**	**Permanent Disability Retirement**
Gender			
Male	1.40**(1.32-1.40)	0.64**(0.61-0.67)	1.75**(1.64-1.88)
Female	1.00	1.00	1.00
Age			
<21	1.00	1.00	1.00
21-25	1.03 (0.97-1.10)	1.46**(1.38-1.54)	1.04 (0.93-1.16)
26-30	0.91* (0.84-0.95)	2.22**(2.08-2.38)	0.72**(0.64-0.81)
31-35	0.85**(0.76-0.96)	2.22**(2.05-2.41)	0.61**(0.53-0.69)
36-40	0.97 (0.80-1.19)	1.33**(1.21-1.41)	0.87* (0.75-1.00)
>40	0.88 (0.58-1.33)	0.74**(0.65-0.83)	1.33** (1.10-1.54)
Race/ethnicity			
White	1.00	1.00	1.00
Black	1.51**(1.43-1.59)	0.77**(0.74-0.80)	1.23**(1.16-1.29)
Hispanic	0.97 (0.86-1.08)	1.03 (0.95-1.12)	0.98 (0.88-1.10)
Other	1.23**(1.10-1.38)	0.95 (0.88-1.03)	0.97 (0.87-1.08)
Marital status			
Single	1.26** (1.20-1.33)	0.66**(0.65-0.71)	1.35**(1.27-1.43)
Married	1.00	1.00	1.00
Separated/divorced	1.12 (0.97-1.31)	1.28**(1.17-1.41)	0.67**(0.60-0.75)
Education			
High school	1.00	1.00	1.00
Some college	1.04 (0.91-1.19)	0.58**(0.54-0.62)	1.92**(1.77-2.08)
College	1.23**(1.08-1.41)	0.78**(0.71-0.86)	1.19**(1.06-1.35)
Rank			
E1-E4	1.00	1.00	1.00
E5-E6	0.71**(0.63-0.80)	1.13**(1.07-1.20)	1.28**(1.20-1.38)
E7-E9	1.40 (0.79-2.49)	0.22**(0.20-0.24)	4.03**(3.58-4.53)
Officer	2.15**(1.81-2.55)	0.37**(0.33-0.42)	3.24**(2.81-3.74)
Years in service	0.74**(0.73-0.75)	0.90**(0.89-0.90)	1.25**(1.21-1.26)

**p < .01
*p<.05

Appendix D

U.S. Army Research Institute of Environmental Medicine

Natick, Massachusetts

TECHNICAL REPORT NO. T08-06
DATE May 2008
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PHYSICAL DEMANDS OF ARMY MILITARY OCCUPATIONAL SPECIALTIES: CONSTRUCTING AND APPLYING A CROSSWALK TO EVALUATE THE RELATIONSHIP BETWEEN OCCUPATIONAL PHYSICAL DEMANDS AND HOSPITALIZATIONS

United States Army
Medical Research & Materiel Command

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The investigators have adhered to the policies for protection of human subjects as prescribed in Army Regulation 70-25, and the research was conducted in adherence with the provisions of 32 CFR Part 219.

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Army Military Occupational Specialties (MOSs) for enlisted Soldiers are categorized by their relative level of physical demands. This report compares injury rates among common MOSs stratified by light, moderate and heavy levels of physical job demands. As hypothesized unadjusted odds for experiencing an injury hospitalization increased with increasing level of physical demand. On-duty serious accidents (those resulting in an injury hospitalization) also occurred more frequently among Soldiers in heavy demands jobs, with Soldiers in the heavy demands jobs of Infantrymen, Cavalry Scouts and Indirect Fire Infantrymen particularly at risk for on-duty injuries. In contrast, the odds of experiencing a hospitalization for "any-cause" were lowest for Soldiers in the highest physical demands jobs, followed by moderate demands jobs, with Soldiers in light demands jobs at greatest risk for any-cause hospitalization. The dynamic nature of MOS nomenclature over time makes the study of any temporal patterns or risk factors for injury or disability within an occupational cohort difficult. This report documents the technical and analytic steps taken in order to create a crosswalk for analyzing military occupation codes over time and associations with selected health outcomes. More research is needed to explore long-term chronic conditions and disability related to occupational physical demand and to clarify the independent influence of job demands once demographic factors are controlled.

14. SUBJECT TERMS
Military Occupational Specialty, Physical Demand, TAIHOD, Injury, Hospitalization, Job

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USARIEM TECHNICAL REPORT T08-06

PHYSICAL DEMANDS OF ARMY MILITARY OCCUPATIONAL SPECIALTIES: CONSTRUCTING AND APPLYING A CROSSWALK TO EVALUATE THE RELATIONSHIP BETWEEN OCCUPATIONAL PHYSICAL DEMANDS AND HOSPITALIZATIONS

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May 2008

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LIST OF ACRONYMS

AP	Army Pamphlet
DoD	Department of Defense
MOS	Military Occupational Specialty
DMDC	Defense Manpower Data Center
ICD-9-CM	International Classification of Disease, 9th Revision, Clinical Modification
OR	Odds Ratio
STANAG	NATO Standardized Agreement
TAIHOD	Total Army Injury and Health Outcomes Database

EXECUTIVE SUMMARY

Army Military Occupational Specialties (MOSs) for enlisted Soldiers are categorized by their relative level of physical demands. Ideally this information should be used to insure a Soldier possesses the necessary physical attributes to safely perform an assigned job. The objectives of this report are to compare rates of injury among common MOSs stratified by light, moderate and heavy levels of physical job demands. We hypothesize that Soldiers placed in MOSs with higher levels of occupational physical demands will be at greatest risk for occupational injury, followed by those in moderately demanding jobs. We hypothesize that Soldiers in the least physically demanding jobs will be at lowest risk for occupational injury. A secondary objective of this report is to document the technical and analytic steps taken in order to create a crosswalk that allowed us to follow trends in military occupation codes over time.

The physical demand levels of each enlisted MOS are classified and described in Department of the Army Pamphlet 611-21. The Army Pamphlet also outlines the procedures for evaluating physical abilities throughout a Soldier's career to prevent mismatches between the physical demands of a job and the physical abilities of a Soldier. While there is stated intent to ensure that Soldiers are appropriately matched to occupations based on the physical requirements of a position and the physical capabilities of the individual, it is doubtful such evaluations occur.

With escalating rates of musculoskeletal disability, there is cause for concern about whether Soldiers are appropriately evaluated and then placed in jobs with occupational demands suitable for their physical capabilities throughout their careers. Failure to properly match physical capabilities with physical demands of a job will likely lead to excess injury and disability. While it is expected that there will be variation in the type of injury patterns seen across various occupational specialties because of differential exposures, it is nonetheless important to understand and prevent job-related injuries.

In order to determine whether Soldiers are properly matched to jobs with varying levels of physical demands, it is necessary to compare occupational injury and disability risk patterns across MOSs with varying levels of physical demands. A temporal assessment of the link between occupational exposures and subsequent injury and disability requires the creation of a crosswalk to correctly identify and follow occupational exposures across time. The crosswalk is also necessary in order to link physical demands associated with various occupations to adverse health outcomes. However, what might appear to be a relatively simple endeavor is actually quite challenging. First, there are many MOSs. In 2006 alone there were over 300 MOSs in use to describe the many enlisted military occupations and, historically, there have been over 700 codes used to categorize enlisted military occupations from 1980 to 2006. Second, MOSs change over time in unpredictable ways (e.g., an occupation can be given a new MOS code, while the old code is recycled or dropped; occupations change

over time as some jobs become obsolete or new jobs are added). Third, the latest job demands ranking was published in 1999 and it is not electronically available, so job-demands data for each specific MOS have to be located by reading through the list and then hand-entering the information, which is a very time-consuming but necessary task for any large-scale analyses. The physical job demands data have not been updated since the report was commissioned in 2000, so any new MOSs added after 2000 have not been categorized. To address these challenges we have identified the top 45 most common MOSs in 2000 across three levels of physical demands: light, moderate and heavy. Using a number of primary data sources, we have traced changes in these 45 occupational groups backward and forward in time. We then linked these occupational exposures (light, moderate, heavy demands) to hospitalization outcomes.

Results indicate that the odds for experiencing an injury hospitalization increased with increasing level of physical demand. In contrast, the odds of experiencing a hospitalization for any (all) cause(s) were lowest for Soldiers in the highest physical demands jobs, followed by Soldiers in moderate demands jobs; Soldiers in the light demand jobs were at greatest risk for any-cause hospitalization. On-duty serious accidents (those resulting in an injury hospitalization) occur more frequently among heavy physically demanding jobs. Soldiers in 11B (Infantrymen), 19D (Cavalry Scout) and 11C (Indirect Fire Infantrymen) were at greatest risk for on-the-job injuries resulting in hospitalization within the top 15 selected heavy physically demanding occupations.

Our findings suggest that the MOS assignment and reclassification processes are in need of revisions or more thorough implementation. Furthermore, the dynamic nature of MOS nomenclature over time makes the study of any temporal patterns or risk factors for injury or disability within an occupational cohort difficult. The ability to crosswalk MOS codes over time is a great advantage for the study of any long-term health or behavioral trends among specific military occupations of interest. More research is needed that explores long-term chronic conditions and disability related to occupational physical demand and to clarify the independent influence of job demands once demographic factors are controlled.

INTRODUCTION

In 2006 there were over 300 enlisted military occupational specialties (MOSs) in the U.S. Army comprising job tasks as diverse as infantrymen, medical specialists, and intelligence agents. The Department of the Army Pamphlet (AP) 611-21 classifies each enlisted MOS according to relative physical demands of a job and also lists the physical duties required of each MOS (10). According to AP 611-21, the physical performance duties of "should be used to assess the need for [a Soldier's] MOS reclassification due to physical limitations and to aid in the selection of suitable MOS[s] for those Soldiers requiring reclassification."

Despite the stated intent in AP 611-21 to ensure appropriate matching of Soldiers to jobs relative to physical abilities, there has been concern that Soldiers are not always physically capable of performing their assigned duties. A 1996 General Accounting Office report questioned whether service members in all military branches were able to perform all the physically demanding tasks of their assigned occupations (19). Furthermore, the National Research Council states that there is poor documentation linking level of individual physical fitness to military occupational performance (14). The DoD Joint Technology Coordinating group-5 and U.S. Medical Research and Material Command reviewed military physical fitness standards and concluded that there is a need to better match occupational physical demands with individual physical abilities. Moreover, the report concluded that baseline fitness standards do not adequately represent the level of physical demand required by some military occupational specialties (15). A 1998 review by Costello also concluded that individual performance on the Army Physical Fitness test did not translate into ability to perform the physically demanding tasks of a given MOS (8). This has been documented among active-duty, as well as among military reservists (17), rendering the need to appropriately match Soldiers to jobs according to physical capabilities ever more crucial.

In contrast to these reports, some studies point to evidence that at least some Soldiers are being appropriately matched to occupations suitable for their relative physical capabilities. A 2007 report by Sharp et al. that directly evaluated how well light-wheel mechanics (MOS 63B) perform the tasks required by their MOS (16) found that most 63B Soldiers were able to perform the physically demanding tasks of their MOS. Likewise, Cooper and Arabian's 2002 survey of active-duty military in physically demanding jobs found that over 90% of respondents said that personal physical strength was not a hindrance to their job performance. This was generally corroborated by their supervisors who reported that over 85% of their Soldiers did not have prohibitive physical strength problems (7).

Nevertheless, possible mismatches between Soldiers and highly demanding occupations present cause for concern, as rates of musculoskeletal disability escalate in the Army at large (4, 5). Assuring that enlisted Soldiers are properly matched to occupations appropriate for their level of fitness, strength and physical capabilities is important for the prevention of job-related injuries or disabilities. Some Soldiers in

certain high-demand occupations experience higher rates of specific types of injuries and disabilities, suggesting that the physical demands of those jobs may not have been properly matched with the physical capabilities of those Soldiers. A 1997 study by Amoroso et al. found acute back injury hospitalization rates were highest among female Medical Specialists and male Motor Transport Operators; hospitalization rates for acute derangement of the knee were higher for female Chemical Operations Specialists and both male Equipment Records clerks and male Parts Specialists and male Medical Specialists (3). A study by Lincoln et al. (2002) found Soldiers in electronic equipment repair and other technical occupations to be at increased risk for overall disability. The study also showed that, among men, increased risk of disability discharge was associated with jobs of heavier physical demand, while holding medium physical demanding jobs yielded a decreased risk for back-related disabilities (13). Dunn et al. (2003) found correlations between musculoskeletal injuries and Army Soldiers in combat, communications and intelligence and craft-related occupations. That same study, however, did not find significant relationships between occupational physical demand and disability, but attributed this lack of association to either the interaction of rank or to incomplete data (12).

In order to determine whether Soldiers are serving in jobs that match their physical abilities, it is necessary to compare occupational injury and disability risk patterns across MOSs. However, what might appear to be a relatively simple endeavor is actually quite challenging because of the way in which MOS categories are named and coded and in which the MOS groupings change over time. Nearly 1,400 MOS codes have been used to describe the many occupations within the military from 1980 to 2006, over 700 of which were used to denote enlisted military occupations. A temporal assessment of the link between occupational exposures and subsequent injury or disability requires the creation of a crosswalk to correctly identify and follow occupations (and thus occupational exposures) across time. In addition, the crosswalk is necessary as part of the process to link data on physical demands associated with various occupations to injury.

There are several challenges related to this task. The large number of MOSs over time change in unpredictable ways (e.g., a given job type might, at some point, be assigned a different code and the old code assigned to an entirely new job or simply dropped; occupational specialties also change over time as some jobs become obsolete or new jobs are added). Also, the job demands ranking scale is not available as an electronic database. The job-demands data for each specific MOS have to be located and hand-entered, which is a very time-consuming but necessary task for any large-scale analyses. In addition, physical job demands data have not been updated since the report was published in 1999. Thus, a crosswalk is needed that allows us to follow MOSs from the year in which the physical demands scale was created to comparable MOSs prior to and after that year.

The objectives of this report are to compare rates of injury among common MOSs stratified by light, moderate and heavy levels of physical demand. We hypothesize that Soldiers placed in MOSs with higher levels of occupational physical

demands will be at greatest risk for occupational injury, followed by those in moderately demanding jobs. We hypothesize that Soldiers in the jobs that are least physically demanding will be at lowest risk for occupational injury. If the data support this hypothesis, then this could suggest that the Army should reconsider how Soldiers are assigned to jobs and/or should more actively and systematically evaluate Soldiers' abilities to perform their jobs through their careers, and/or the jobs themselves are too demanding and hazardous even for highly fit and trained Soldiers. A secondary objective of this report is to document the technical and analytic steps taken in order to create a crosswalk that will allow us to follow trends in military occupation codes over time.

METHODS

THE DATA

Data for this study came from the Total Army Injury and Health Outcomes Database (TAIHOD) (3, 6), which uses encrypted individual identifiers to link records on individual Soldiers from a variety of U.S. Department of Defense administrative and health data sources. TAIHOD components used include the Defense Manpower Data Center (DMDC), which contains personnel records with occupational information and, therefore, MOS codes; and the Patient Administration Systems and Biostatistics Activity database, which contains information on inpatient hospitalizations.

THE ARMY PHYSICAL DEMANDS RATINGS

A 1976 report to Congress by the General Comptroller of the United States called for accurate and objective physical standards to measure an individual's physical abilities as they relate to military occupations (18). As more women were entering the military, male-oriented combat restrictions were causing limited or inappropriate assignment of women to occupations based on their physical capabilities, calling for revised measures of physical ability and job-related physical duties. Ratings of physical demands for military occupations were first introduced in 1982 by the Women in the Army Policy Review Group in response to the 1976 report, and gender-neutral physical standards were developed (10, 11).

The job demands scale is ordered from light physical demand to very heavy physical demand with five categories: light, medium, moderately heavy, heavy, and very heavy. Physical demands are determined by the lifting requirements of the job:

Light	Lift, on an occasional basis, a maximum of 20 pounds with frequent or constant lifting of 10 pounds
Medium	Lift, on an occasional basis, a maximum of 50 pounds with frequent or constant lifting of 25 pounds
Moderately Heavy	Lift, on an occasional basis, a maximum of 80 pounds with frequent or constant lifting of 40 pounds
Heavy	Lift, on an occasional basis, a maximum of 100 pounds with frequent or constant lifting of 50 pounds
Very Heavy	Lift, on an occasional basis, over 100 pounds with frequent or constant lifting in excess of 50 pounds

Army Pamphlet 611-21 (10) provides information on physical demand level assignments for enlisted MOS codes. Prior experience with MOS physical demands classification led us to confidently collapse demand categories into 3-levels of physical demands for analysis. Light and medium physically demanding jobs were collapsed as "light;" moderately heavy remained as its own category ("moderate"); and heavy and very heavy physically demanding jobs were collapsed into "heavy." This was done to facilitate interpretation of findings, improve homogeneity of job demands categories and simplify the task of hand-coding all MOSs with a job demands code.

OCCUPATIONAL INJURY

Occupational injuries were evaluated using injury hospitalization data. Hospital data used for this study included dates of care, diagnostic codes and cause of injury codes. Diagnostic codes are recorded according to International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM). Hospitalizations can contain up to eight ICD-9-CM codes denoting both the primary and subordinate diagnoses. A hospitalization was considered an injury-related event when an injury diagnosis (ICD-9-CM codes 800-995) appeared in the primary diagnostic position of the hospital record. Likewise, a hospitalization was classified as a musculoskeletal-related event by the presence of a musculoskeletal diagnosis (ICD-9-CM codes 710-740) in the primary position.

When a hospitalization contains an injury diagnosis, administrative recorders are directed to complete a field for a range of codes that signify the cause of ("injury") and nature surrounding ("trauma") a specific injury defined by a North Atlantic Treaty Organization Standardization Agreement 2050 (STANAG). These are similar to the civilian use of E-codes. Unlike civilian hospitalization systems, where coding of injury causes is often incomplete and varies dramatically from state to state (9), the military system achieves a much higher rate of reporting cause of injury (virtually 100%). "Trauma" codes, which address intent and occupational exposures, are more likely to

be coded as unknown than the "injury" (proximal cause) portion of the STANAG code (1, 2). However, when available, these STANAG "trauma" codes can signify, among other details, if an injury was sustained on- or off-duty.

STUDY POPULATION

The initial potential study pool comprised all active-duty Army Soldiers between 1980 and 2006. There were 3,449,097 Soldiers on active duty between 1980 and 2006.

ANALYSES

Constructing the MOS Crosswalk and Linking to Job Demand Classifications

Because construction of the MOS crosswalk was complicated and time consuming and the job demands codes had to be hand-entered, we decided to begin with a single year in order to test our approach and refine our methods. We decided to focus on the most common MOSs in 2000, reasoning that since the AP 611-21 was most recently updated in 1999, 2000 data would be the first full year that the MOS codes and their respective physical demand categories were presumably in effect and, thus, findings would be most relevant to Soldiers on active duty in that year.

We used a Soldier's last available DMDC personnel file for the year 2000 (Soldiers can have up to 2 personnel records per year in the TAIHOD) to identify their MOS. We also simplified our approach by focusing just on the most common MOSs, by population. After identifying the most common MOSs and insuring that we had representation of common jobs in all three job demands categories, we extended our assessment by identifying Soldiers in these top MOSs in prior and later years of the study period (1980– 2006). Details are provided below.

To identify the most common MOS codes, we rank ordered all MOS codes in the year 2000 by frequency from largest to smallest. Military occupations that were eliminated or obsolete by 2000 were not represented. There were 469,262 Soldiers on active duty in the year 2000, 393,301 (83.81%) were males, 75,474 (16.08%) were females, and 517 (0.11%) Soldiers were of unknown gender. The mean age for the entire 2000 active-duty Army population was 27.34 ($\pm$ 6.69), 27.48 ($\pm$ 6.67) for males, and 26.60 ($\pm$ 6.84) for females.

The data on job demands rankings was hand-entered for each of MOS. Of the top 50 most common MOS codes in 2000, 62% (N=31) were of heavy physical demand, 26% (N=13) were moderate, and 8% (N=4) were of light physical demand. Two of the 50 most common MOS codes in 2000 (Recruiter [79R] and Practical Nurse [91C]) were not assigned a physical demand rating in the AP 611-21.

In order to have a representative sample of all the physical demand levels, we selected the top15 MOSs within each of the three physical demand categories: heavy, moderate and light (comprising 64% of the total population) for analysis. The remainder

of this report focuses on these 45 MOSs representing the 15 most common light-, 15 most common medium- and 15 most common heavy-demands jobs in the Army in 2000. The first stage of this report (Table 1 and its related text) describes the population in the most common MOSs as identified by a Soldier's last DMDC personnel record (N=300,356).

Once the key MOSs were identified, the next step was to expand our population in the year 2000 by searching for the appearance of these codes anywhere in a Soldier's 2000 personnel files. Since our original approach to identifying common MOSs was to take the last MOS code on record in 2000, if a Soldier held a MOS code of interest in June but a different MOS code (not within the top 45 codes) in December, that Soldier would have been missed by our original MOS detection described above. By applying our expanded approach of searching for the existence of the top 45 codes in any 2000 record for a Soldier, we were able to increase our study population. For Soldiers with an MOS of interest in June 2000 (for example, heavy) and another MOS of interest in December 2000 (for example, light), one file per Soldier in 2000 was selected for analysis. The resulting study population for analysis was 305,708 Soldiers. Tables 2-4, and their accompanying text, use this expanded 2000 study population (N=305,708).

The final step in this process was to extend the analysis to include Soldiers in these key occupational groups who were on active duty during prior and more recent years. In order to do this, we needed to identify Soldiers in each of the top 45 MOSs of interest within each 6-month DMDC file for each MOS over the 27 year study period. This meant careful review of data within each of the 54 six-month files for each of the 45 jobs, or a total of 2,430 analytic reviews. Since MOS codes are often changed, eliminated or recycled, this time-intensive approach was necessary in order to carefully follow each occupation from 1980 through 2006. We had to meticulously trace each occupation through coding and occupational name changes from 2000 back to 1980 and then from 2000 up through 2006. We relied on multiple sources of information including a military occupational coding expert at DMDC, and MOS tables referred to as Conversion Tables provided by DMDC. The conversion tables we were forced to rely on were not designed to convert occupations over time, but rather to document years in which a certain MOS code was assigned to a certain occupation. Identification of coding changes and MOS titles thus required a very complex series of research, programming and data checks to identify the proper related MOS codes over a 27 year period and link them together. While time consuming, this task was necessary in order for us to explore injury and other health outcomes associated with different job demands for a large population of enlisted Soldiers over time. Tables 5-17, Figure 1 and all related text describe the cross-walked population over this 27 year period.

Association between Job Demands and Injury and Other Health Outcomes

We explored frequencies of hospitalizations for injury, hospitalizations for musculoskeletal-related conditions, and any-cause hospitalization among the most common MOS codes for enlisted U.S. Army Soldiers, stratified on the MOS's job

demands. Initial analyses focused just on Soldiers on active duty in 2000. Since a Soldier's military occupation can change during a year, hospitalization rates are provided using hospital events experienced within one year of a Soldier's qualifying personnel file. Mantel Haenszel Chi square analysis was used to identify significant differences in injury hospitalizations between light, moderate and heavy physically demanding occupations. Odds ratios (ORs) and 95% confidence intervals are reported.

Frequencies and percentages of Soldiers in 45 occupational groups of interest for the years 1980-2006 were reported in which calculation of a percentage was possible. Unadjusted annual hospitalization injury rates within the top 45 occupations are reported by year, stratified by light, moderate and heavy job demands. A summary graph was constructed by calculating the average annual rates for injury hospitalizations, musculoskeletal hospitalizations, and any hospitalizations over the entire 27-year study period for each of the three physical demand levels.

Analyses for this research were performed with SAS, Version 9 (SAS Institute, Cary, NC). All analyses for this project adhere to the policies for the protection of human subjects, as prescribed in Army Regulation 70-25, and with the provisions of 45 CFR 46.

RESULTS

Table 1 shows the identified 45 most common physically demanding MOSs among enlisted Army Soldiers in 2000, stratified by heavy, moderate and light demands. There were 300,356 Soldiers with one of the top 45 most common MOS codes in the year 2000: 247,236 (82.31%) were male, and 53,116 (17.68%) were female (less than 1% were of unknown gender (N=4)). The most common occupations were Infantrymen (11B) (Heavy Demands) (6.67%), Medical Specialist (91B) (Moderate Demands) (3.90%), and Military Police (95B) (Moderate Demands) (3.36%). The top 15 heavy physical demand occupations comprised 39.87% of the entire 2000 Army population; the top 15 moderate occupations comprised 16.87%, and the top 15 light occupations made up 7.2% of the entire active-duty Army population in 2000.

Nine of the 45 jobs identified were only open to male Soldiers (20%): seven within the heavy job demands list, one within the moderate and one within the light job demands MOS list. While men were more likely to be in the heavy demands jobs than women, there were some female Soldiers (12.1%) in the heavy demands group. Of the 187,110 Soldiers who comprised the top 15 heavy MOS codes in 2000, 87.90% were male and 12.10% were female. There were 79,078 Soldiers in the top 15 moderate MOS codes: 76.80% males and 23.20% females. Of the 34,168 Soldiers classified in the top 15 light MOS, 64.51% were male and 35.49% were female.

The average age for Soldiers in the top 45 MOS codes was 27.06 years ($\pm$ 6.64) (41, 0.01%, were missing an age value). Soldiers in the top 15 heavy MOS codes had a mean age of 26.79 ($\pm$ 6.51) with very little differentiation between males and females: 26.87 ($\pm$ 6.51) for males, and 26.16 ($\pm$ 6.45) for females. The mean age for the overall

moderate physical demand group was 27.35 (± 6.70); 27.62 (± 6.70) for males and 26.48 (± 6.64) for females. Among Soldiers in the light physical demand group, overall mean age was 27.85 (± 7.08); 27.98 (± 7.02) for males and 27.62 (± 7.17) for females.

Table 1. Crosswalk of Military Occupational Specialties with Level of Physical Demand, 2000 (N=469,292 Total Population).

Military Occupational Specialty	Frequency (2000)	Percent of Total[a] (2000)	Male in MOS N (%)	Female in MOS N (%)	Mean Age (Years ± SD)	Mean Age Males (Years ± SD)	Mean Age Females (Years ± SD)
Heavy Demands Jobs					*26.79(± 6.51)*	*26.87(± 6.51)*	*26.16(± 6.45)*
11B Infantryman [b]	31,299	6.67%	31,274 (99.92%)	25 (0.08%)	26.27(± 6.33)	26.26(± 6.33)	32.93(± 7.55)
11M Fighting Vehicle Infantryman [b]	15,053	3.21%	15,044 (99.94%)	9 (0.06%)	26.47(± 6.41)	26.47(± 6.41)	35.93(± 5.93)
92A Automated Logistical Specialist	14,932	3.18%	9,143 (61.23%)	5,789 (38.77%)	27.30(± 6.66)	28.11(± 6.78)	26.03(± 6.24)
92Y Unit Supply Specialist	14,781	3.15%	9,801 (66.31%)	4,980 (33.69%)	28.01(± 7.29)	28.82(± 7.33)	26.44(± 6.95)
88M Motor Transport Operator	13,530	2.88%	10,652 (78.73%)	2,877 (21.26%)	27.37(± 6.38)	27.79(± 6.43)	25.81(± 5.92)
19K M1 Armor Crewman [b]	12,476	2.66%	12,473 (99.98%)	3 (0.02%)	26.96(± 6.37)	26.96(± 6.37)	26.54(± 3.38)
63B Light-wheel Vehicle Mechanic	12,608	2.69%	11,449 (90.80%)	1,158 (9.18%)	26.92(± 6.61)	26.96(± 6.64)	26.46(± 6.29)
13B Cannon Crewmember [b]	11,500	2.45%	11,497 (99.97%)	3 (0.03%)	26.82(± 6.33)	26.82(± 6.33)	31.43(± 4.48)
12B Combat Engineer [b]	11,393	2.43%	11,385 (99.93%)	8 (0.07%)	25.85(± 6.16)	25.85(± 6.15)	30.13(± 7.17)
92G Food Service Operations	11,130	2.37%	8,075 (72.55%)	3,055 (27.45%)	27.89(± 6.94)	28.11(± 6.91)	27.32(± 6.98)
77F Petroleum Supply Specialist	9,286	1.98%	6,919 (74.51%)	2,367(25.81%)	26.35(± 5.90)	26.60(± 5.98)	25.62(± 5.60)
19D Cavalry Scout [b]	8,831	1.88%	8,829 (99.98%)	2 (0.02%)	25.73(± 6.16)	25.73(± 6.16)	34.37(± 2.07)
54B Chemical Operations Specialist	7,382	1.57%	5,892 (79.82%)	1,490 (20.18%)	27.84(± 7.44)	28.46(± 7.42)	25.39(± 7.01)
31R Multichannel Transmission System Operator/Maintainer	7,326	1.56%	6,453 (88.08%)	873 (11.92%)	25.38(± 5.23)	25.39(± 5.19)	25.28(± 5.47)
11C Indirect Fire Infantrymen [b]	5,583	1.19%	5579 (99.93%)	4 (0.07%)	26.42 (±6.18)	26.42(± 6.18)	37.55(± 4.92)
Moderate Demands Jobs					*27.35(± 6.70)*	*27.62(± 6.70)*	*26.48(± 6.64)*
91B Medical Specialist	18,285	3.90%	12,614 (68.99%)	5,671 (31.01%)	27.28(± 6.49)	28.04(± 6.53)	25.59(± 6.06)
95B Military Police	15,755	3.36%	13,218 (83.90%)	2,537 (16.10%)	27.03(±6.45)	27.45(± 6.51)	24.87(± 5.70)
31U Signal Support Systems Specialist	9,239	1.97%	8,221 (88.98%)	1,018 (11.02%)	26.38(± 6.42)	26.56(± 6.49)	24.93(± 5.68)
75H Personnel Services Specialist	8,679	1.85%	5,321 (61.31%)	3,358 (38.69%)	30.63(± 7.70)	31.10(± 7.72)	29.89(± 7.61)
75B Personnel Administration Assistant	4,218	0.90%	2,590 (61.40%)	1,627 (38.57%)	25.02(± 5.00)	25.39(± 4.95)	24.44(± 5.02)
13M Multiple Rocket Launch System Crewmember [b]	3,408	0.73%	3,407 (99.97%)	1 (0.03%)	27.28(± 6.79)	27.28(± 6.79)	36.41 --
14T PATRIOT Launching Station Enhanced Operator/Maintainer	2,711	0.58%	2,196 (81.00%)	515 (19.00%)	25.66(± 5.81)	26.03(± 5.91)	24.06(± 5.03)
98C Signals Intelligence Analyst	2,446	0.52%	1,846 (75.47%)	599 (24.49%)	27.86(± 6.79)	28.17(± 6.74)	26.91(± 6.89)

Table 1 Continued.

Military Occupational Specialty	Frequency (2000)	Percent of Total[a] (2000)	Male in MOS N (%)	Female in MOS N (%)	Mean Age (Years ± SD)	Mean Age Males (Years ± SD)	Mean Age Females (Years ± SD)
74C Telecommunications Operator-Maintainer	2,246	0.48%	1,497 (66.65%)	749 (33.35%)	27.90(± 6.82)	28.06(± 6.69)	27.60(± 7.05)
31S Satellite Communications Systems Operator-Maintainer	2,188	0.47%	2,034 (92.96%)	154 (7.04%)	26.78(± 6.05)	26.84(± 6.08)	25.93(± 5.72)
91K Medical Laboratory Specialist	2,091	0.45%	1,201 (57.44%)	890 (42.56%)	29.31(± 6.90)	30.10(± 7.03)	28.23(± 6.57)
67R AH-64 Attach Helicopter Repairer	2,110	0.45%	1,968 (93.27%)	142 (6.73%)	26.49(± 6.03)	26.58(± 6.09)	25.13(± 4.90)
35E Radio and Communications Security Repairer	2,031	0.43%	1,796 (88.43%)	235 (11.57%)	26.10(± 5.87)	26.26(± 5.91)	24.82(± 5.36)
88N Transportation Management Coordinator	1,929	0.41%	1,295 (67.13%)	634 (32.87%)	27.72(± 6.86)	27.32(± 6.64)	28.53(± 7.21)
31P Microwave Systems Operator-Maintainer	1,742	0.37%	1,524 (87.49%)	218 (12.51%)	27.33(± 7.38)	27.03(± 7.23)	26.40(± 8.08)
Light Demands Jobs					*27.85(± 7.08)*	*27.98(± 7.02)*	*27.62(± 7.17)*
71L Administrative Specialist	11,341	2.42%	5,472 (48.25%)	5,869 (51.75%)	28.50(± 7.19)	28.46(± 7.16)	28.54(± 7.22)
96B Intelligence Analyst	4,378	0.93%	3,471 (79.28%)	907 (20.72%)	26.53(± 6.84)	26.91(± 6.78)	25.07(± 6.88)
73C Finance Specialist	2,220	0.47%	1,258 (56.67%)	962 (43.33%)	28.40(± 7.17)	29.14(± 7.17)	27.44(± 7.05)
93P Aviation Operations Specialist	2,127	0.45%	1,467 (68.97%)	660 (31.03%)	27.79(± 7.49)	28.59(± 7.57)	26.02(± 7.00)
71D Legal Specialist	1,828	0.39%	1,111 (60.78%)	717 (39.22%)	28.70(± 7.24)	28.73(± 7.16)	28.66(± 7.36)
97B Counterintelligence Agent	1,714	0.37%	1,371 (79.99%)	343 (20.01%)	27.32(± 6.51)	27.58(± 6.61)	26.28(± 5.98)
76J Medical Supply Specialist	1,628	0.35%	939 (57.68%)	689 (42.32%)	28.37(± 7.02)	29.10(± 6.86)	27.38(± 7.11)
14R BRADLEY Linebacker Crewmember[b]	1,411	0.30%	1,407 (99.72%)	4 (0.28%)	26.81(± 6.48)	26.79(± 6.45)	33.58(± 11.06)
14E PATRIOT Fire Control Enhanced Operator Maintainer	1,360	0.29%	1,256 (92.35%)	104 (7.35%)	27.38(± 6.70)	27.53(± 6.66)	25.58(± 6.50)
91D Operating Room Specialist	1,245	0.27%	736 (61.04%)	509 (40.88%)	27.85(± 6.34)	28.58(± 6.15)	26.79(± 6.46)
33W Electronic Warfare / Intercept Systems Repairer	1,184	0.25%	1,081 (91.30%)	103 (8.70%)	26.04(± 6.96)	26.23(± 7.08)	24.12(± 5.29)
96D Imagery Analyst	1,053	0.22%	786 (74.64%)	267 (25.36%)	26.23(± 7.11)	26.63(± 7.22)	25.06(± 6.63)
71G Patient Administration Specialist	1,049	0.22%	555 (52.91%)	494 (47.09%)	28.06(± 7.27)	29.08(± 7.09)	26.91(± 7.31)
97E Human Intelligence Collector	871	0.19%	626 (71.87%)	245 (28.13%)	28.89(± 6.71)	29.33(± 6.65)	27.42(± 6.73)
91S Preventive Medicine Specialist	759	0.16%	507 (66.80%)	252 (33.20%)	28.72(± 7.10)	29.22(± 7.06)	27.72(± 7.10)

[a] Denominator represents total population for the Army in 2000 (N=469,292).

[b] Occupation restricted to males only.

HOSPITALIZATION RISK BY MOS PHYSICAL DEMAND LEVELS

This portion of the report describes hospitalizations for injuries, musculoskeletal conditions, and any-cause among Soldiers identified in the top 45 most common military occupations by levels of physical demand during the year 2000. All Soldiers on active duty in the year 2000 who held one of the top 45 (15 heavy, 15 moderate and 15 light) MOS job codes were included in the analysis (N=305,708).

Of all Soldiers identified in the year 2000 in our top 45 MOS categories, 4.95% (N=15,121) experienced a hospitalization during the 1 year follow-up time period. Just under 1% (0.87% (N=2,669)) experienced an injury hospitalization and less than 0.69% (N=2,098) experienced a hospitalization with a "Musculoskeletal System/Connective Tissue Disease" diagnosis.

Tables 2-4 (below) compare the frequencies of hospitalizations experienced across the three levels of physical demand. There are *decreasing* odds of overall hospitalization as physical demand increases (Chi-square for linear trend = 237, p<.0001). Compared to heavy physical demand, Soldiers in light or moderate physically demanding jobs were more likely to experience a hospitalization within 1 year of holding that occupation (OR= 1.40 (95% CI=1.35-1.48 and 1.20; 95%CI=1.16-1.25, respectively). If moderate and light groups are combined, Soldiers in a heavy occupation are 0.79 (95% CI = 0.76-0.82) times less likely than all other groups to experience a hospitalization (Table 2).

Table 2. MOS Physical Demand Levels (2000) and Hospitalizations Experienced within 1 Year (Any Reason).

	MOS Physical Demand Levels			
	Heavy N=190,618 (Row %) (Column %)	Moderate N=80,292 (Row %) (Column %)	Light N=34,798 (Row %) (Column %)	Total N=305,708 (Row %) (Column %)
Any Hospitalization within 1 year	8,612 56.95% 4.52%	4,329 28.63% 5.39%	2,180 14.42% 6.26%	15,121 -- 4.95%
No Hospitalization within 1 year	182,006 62.63% 95.48%	75,963 26.14% 94.61%	32,618 11.22% 93.74%	290,587 -- 95.05%

Chi-square = 236.91, p<.0001
mHx^2 = 126.85, p<.0001

In contrast to any-cause hospitalizations, the odds for an injury-related hospitalization *increase* with increasing levels of physical demand. Compared to the heavy-demands group, Soldiers in the moderate- or light-demands groups had lower odds of experiencing an injury-related hospitalization (OR=0.80, 95%CI = 0.73-0.88 and

OR-0.67, 95%CI=0.58-0.77, respectively). In addition, the chi-square statistic for linear trend was statistically significant (47, p<.0001) (Table 3).

Table 3. MOS Physical Demand Levels (2000) and Hospitalizations Experienced within 1 Year (with Injury Diagnosis in the Primary Position).

	MOS Physical Demand Levels			
	Heavy N=190,618 (Row %) (Column %)	Moderate N=80,292 (Row %) (Column %)	Light N=34,798 (Row %) (Column %)	Total N=305,708 (Row %) (Column %)
Injury Hospitalization within 1 year	1,826 68.42% 0.96%	620 23.23% 0.77%	223 8.36% 0.64%	2,669 -- 0.87%
No Injury Hospitalization within 1 year	188,792 62.30% 99.04%	79,672 26.29% 99.23%	34,575 11.41% 99.36%	303,039 -- 99.23%

Chi-square = 46.99, p<.0001
mHx^2 = 29.47, p<.0001

While Soldiers in highly physically demanding jobs in 2000 appear to be at greater risk for an injury hospitalization, there were no statistically significant differences in risk for a musculoskeletal disorder hospitalization. Even though musculoskeletal disorders are often associated with injury events or long-range consequences of old injuries, the OR for musculoskeletal disorder hospitalizations among those in heavy demand jobs was 0.93 (compared to moderate and light demand jobs combined) and the 95% CI was 0.85 – 1.02 (p <.122) (Table 4).

Table 4. MOS Physical Demand Levels (2000) and Hospitalizations Experienced within 1 Year (with Musculoskeletal Diagnosis in the Primary Position).

	MOS Physical Demand Levels			
	Heavy N=190,618 (Row %) (Column %)	Moderate N=80,292 (Row %) (Column %)	Light N=34,798 (Row %) (Column %)	Total N=305,708 (Row %) (Column %)
Musculoskeletal Hospitalization within 1 year	1,274 60.72% 0.67%	582 27.74% 0.72%	242 11.53% 0.70%	2,098 -- 0.69%
No Musculoskeletal Hospitalization within 1 year	189,344 62.36% 99.33%	79,710 26.25% 99.28%	34,556 11.38% 99.30%	303,610 -- 99.31%

Chi-square = 2.69, p<.2599
mHx^2 = 2.67, p<.2631

TEMPORAL CROSSWALK OF 45 SELECTED MOS CODES, 1980 – 2006

This section of the report details results from the linkage of the top 45 identified MOSs in 2000 to MOSs in 1980-2006. As we expected, in tracking these MOS codes over time, we learned that some of them were not used consistently throughout the study period. We found that only 10 of the 15 heavy demands occupations, 10 of the light demands MOSs and only 6 of the moderately demanding MOS codes were populated throughout the entire study period (1980-2006).

There is little that can be done about the discontinuation of a job or the initiation of a new one that overlaps with a prior MOS code. Thus, other than take into account these changes when we calculated average frequencies for the occupation each year, no other adjustments were made. When these or similar MOS changes occurred, we calculated average frequencies and average percentages of the total population using only the years in which these codes were in use. MOSs that were affected by discontinuation or which were added in the middle or end of the study period are marked by an asterisk in Table 5 along with information regarding the years in which they were available. It is possible that these codes represent newly added occupations within the military that did not exist in prior years. It is also possible, however, that these occupations did exist, but that we have been unable to track down either their predecessors or successors in the MOS coding system because of an undocumented change in nomenclature. Our crosswalk procedures thus highlight the challenges and inherent limitations of using MOS codes for research purposes. While we are able to follow certain occupations accurately over the study period, there are likely to be code transitions that we cannot account for. As such, the reader should interpret findings with caution, noting that a sudden increase or decrease in annual frequencies of Soldiers assigned to a given MOS code may represent a real change in the proportion of Soldiers assigned to that occupation, or it may reflect either redistribution of Soldiers previously assigned to other MOSs or the collapsing of codes by the Army. While these limitations do exist, our ability to track codes over time is still an important objective and necessary in order to inform temporal research utilizing occupational cohorts.

Our research revealed that of the 45 occupations, 25 (56%) of the codes used in 2000 had different MOS designator codes throughout our study period. For example, a Petroleum Supply Specialist was assigned 77F from April 1986 to September 2003 and then assigned the MOS code 92F from September 2003 forward. In some cases, we found evidence suggesting that the conversion table guiding our assessment of MOS changes was incomplete or contained errors, typically with regard to the date when a change in occupational code was implemented. For example, while the conversion tables indicate that MOS code 76W was used from 1967 to 1993, this would have resulted in an overlap with the code that replaced it, 77F. Further analysis of annual frequencies for these codes suggested strongly that the 76W MOS code was actually phased out of use beginning in 1986 and not 1993, as indicated in the conversion table. In any case, all three codes (76W, 77F and 92F) needed to be crosswalked in order to identify Soldiers who spent time as a Petroleum Supply Specialist during the study period.

In some cases, the evolution of codes made tracking an occupational group across time quite complicated. For example, in 2000, MOS code 54B was assigned to Chemical Operations Specialist. This code was used for this occupational group from October 1987 through September 2003. However, prior to this time, the alphanumeric code "54B" had been used to denote an entirely different job: Decontamination Specialist. After September 2003, Chemical Operations Specialists were given code 74D for their military occupation to replace 54B. Yet, from 1965 to April 1995, 74D was used for an Information Systems Operator. When an MOS code was, in essence, "recycled," as in this case, we interpreted codes using a combination of information including the dates in the conversion table and actual frequencies and population counts for the codes.

Another similar example, 71D was assigned to Legal Assistant from May 1965 through April 2001. Also, from October 2000 forward, 27D denoted Paralegal Assistant. Since 71D was phased out, we believed that Legal Assistant and Paralegal Assistant were synonymous even though the years the codes were implemented overlapped. Likewise, code 27D referred to a LANCE Missile System Repairman from January 1967 to May 1977 and then to a ROLAND Repairer from September 1981 through October 1989. A LANCE Repairer was subsequently reassigned at various times to MOS codes 27L, 27E, 94A, 35A at times under a variation of the title. A ROLAND Repairer was also assigned different MOS codes throughout our study period. In other cases, specific codes of interest were eliminated and the associated occupation was collapsed into another occupational category. For example, 11M was used to denote Fighting Vehicle Infantrymen from 1983 to 2002 when the code was then discontinued. A less common MOS code, 11H (Heavy Anti-armor Weapons Infantryman) was discontinued in September 2002. Both 11M and 11H were then collapsed into 11B (Infantrymen). Since 11M and 11B were both among our top 15 most common heavy MOS codes, we chose not to retroactively collapse them for the duration of the study period. To first identify and then resolve these discrepancies and others that are similar, the data specialist had to look at the distribution of each code over every 6-month file and then link them to the related codes over the proper time periods accordingly.

All of these examples are provided to give insight into the complexity of the task of cross-walking Army MOSs over time and to also alert the reader to the decisions that were made in order to fully utilize the information available and to avoid loss of cases. Table 5 summarizes the results from the MOS crosswalk. Percentages are given based on the relative proportion of the total enlisted Army (N=3,449,097 from 1980-2006), as well as by gender (total enlisted females throughout the study period (N=484,403 from 1980-2006) and total enlisted male population (N=2,957,338 from 1980-2006)).

Table 5. Top 15 Military Occupations for Light, Moderate and Heavy Levels of Physical Demands, 1980-2006.

Military Occupational Specialty	Physical Demands	Total Army		Males		Females	
		Average Frequency	Average Percent	Average Frequency	Average Percent	Average Frequency	Average Percent
Heavy/Very Heavy Demands Jobs							
11B Infantryman	Heavy	53,886	8.60%	53,786	9.87%	91	0.12%
13B Cannon Crewmember	Heavy	21,775	3.33%	21,747	3.81%	23	0.03
63B Light-wheel Vehicle Mechanic	Heavy	20,610	3.24%	19,123	3.43%	1,485	1.91%
92Y Unit Supply Specialist	Heavy	20,012	3.17%	15,428	2.73%	4,568	5.90%
88M Motor Transport Operator	Heavy	19,163	3.00%	16,470	2.92%	2.690	3.47%
92A Automated Logistical Specialist*1993-2006	Heavy	14,730	3.03%	9,311	2.25%	5,417	7.45%
12B Combat Engineer	Heavy	14,045	2.24%	14,028	2.57%	15	0.02%
19K M1 Armor Crewman*1982-2006	Heavy	13,151	2.31%	13,135	2.68%	14	0.02%
11M Fighting Vehicle Infantryman*1983-2002	Heavy	12,473	2.18%	12,450	2.52%	20	0.03%
19D Cavalry Scout	Heavy	11,105	1.81%	11,091	2.08%	13	0.02%
92G Food Service Operations*1995-2006	Heavy	11,071	2.33%	7,861	1.96%	3,210	4.38%
11C Indirect Fire Infantrymen	Heavy	9,234	1.44%	9,225	1.64%	7	0.01%
77F Petroleum Supply Specialist	Heavy	9,256	1.59%	7,455	1.47%	1,800	2.36%
31R Multichannel Transmission System Operator/Maintainer	Heavy	8,180	1.32%	7,099	1.33%	1,080	1.36%
54B Chemical Operations Specialist*1987-2006	Heavy	8,209	1.49%	7,002	1.47%	1,204	1.61%
Moderate Demands Jobs							
95B Military Police	Moderate	23,136	3.66%	20,257	3.65%	2,885	3.70%
91B Medical Specialist*1981-2006	Moderate	18,535	3.221%	14,273	2.82%	4,258	5.63%
31U Signal Support Systems Specialist*1993-2006	Moderate	9,087	1.87%	8,056	1.95%	1,029	1.42%
75H Personnel Services Specialist*1996-2003	Moderate	7,233	1.54%	4,467	1.13%	2,765	3.74%
75B Personnel Administration Assistant	Moderate	7,167	1.19%	5,000	0.94%	2,165	2.83%
98C Signals Intelligence Analyst	Moderate	3,104	0.51%	2,327	0.45%	777	0.99%
13M Multiple Rocket Launch System Crewmember*1982-2006	Moderate	3,232	0.59%	3,229	0.69%	2.3	0.00%
14T PATRIOT Launching Station Enhanced Operator/Maintainer*1997-2006	Moderate	2,730	0.58%	2,189	0.55%	540	0.73%
74C Telecommunications Operator-Maintainer*1995-2006	Moderate	2,310	0.48%	1,515	0.37%	794	1.09%
91K Medical Laboratory Specialist	Moderate	2,552	0.42%	1,542	0.29%	1,010	1.30%

Table 5 Continued.

Military Occupational Specialty	Physical Demands	Total Army		Males		Females	
		Average Frequency	Average Percent	Average Frequency	Average Percent	Average Frequency	Average Percent
Heavy/Very Heavy Demands Jobs	Moderate	1,994	0.37%	1,347	0.29%	647	0.85%
31S Satellite Communications Systems Operator-Maintainer	Moderate	1,750	0.32%	1,634	0.35%	116	0.15%
31P Microwave Systems Operator-Maintainer*1986-2006	Moderate	1,529	0.29%	1,436	0.30%	161	0.22%
67R AH-64 Attach Helicopter Repairer*1985-2006	Moderate	1,789	0.34%	1,684	0.37%	105	0.14%
Light/Medium Demands Jobs							
71L Administrative Specialist	Light	19,209	2.92%	11,062	1.88%	8,135	10.26%
96B Intelligence Analyst	Light	3,891	0.68%	3,150	0.63%	740	0.96%
73C Finance Specialist	Light	3,548	0.56%	2,327	0.41%	1,219	1.55%
71D Legal Specialist	Light	2,080	0.34%	1,403	0.26%	676	0.87%
93P Aviation Operations Specialist*1984-2003	Light	2,147	0.39%	1,544	0.32%	603	0.79%
76J Medical Supply Specialist* 1980-2002/2004-2006	Light	1,905	0.31%	1,239	0.23%	666	0.86%
91D Operating Room Specialist	Light	1,709	0.27%	1,132	0.20%	577	0.74%
71G Patient Administration Specialist	Light	1,507	0.24%	915	0.16%	592	0.75%
97B Counterintelligence Agent	Light	1,597	0.25%	1,317	0.26%	280	0.37%
14E PATRIOT Fire Control Enhanced Operator Maintainer*1997-2003	Light	1,425	0.30%	1,300	0.33%	125	0.17%
14R BRADLEY Linebacker Crewmember*1992-2003	Light	1,308	0.27%	1305	0.32%	3	0.00%
33W Electronic Warfare/Intercept Systems Repairer*1999-2003	Light	1,327	0.28%	1221	0.30%	106	0.14%
97E Human Intelligence Collector	Light	1,270	0.22%	945	0.19%	325	0.42%
96D Imagery Analyst	Light	934	0.16%	705	0.14%	229	0.30%
91S Preventive Medicine Specialist	Light	830	0.14%	539	0.10%	291	0.37%

* Indicates the years this specific code was used, if not used for entire study period.

HOSPITALIZATIONS BY JOB DEMANDS, TOP 45 JOBS, 1980 – 2006

Once exposures to varying job demands across years (1980-2006) were assessed, the next step was to link these exposures to health outcomes. Tables 6-14 below report annual unadjusted hospitalization rates for each of the selected 45 MOSs, stratified by year (1980-2006) and job demands. In some cases, temporal patterns in the MOS did not allow for the calculation of a rate (as noted in the table).

Heavy Physical Demands

As with the data from just the year 2000 sample, Soldiers in heavy physically demanding occupations experienced higher injury-related hospitalizations than those in light and moderately demanding jobs. Infantrymen generally had slightly higher rates of injury hospitalizations throughout the study period (1938 per 100,000 11B population) than did all other heavy physical demand occupations. Within the heavy demands occupations, musculoskeletal disorder hospitalization rates increased steadily until 1996 when there was a dramatic decrease in rates. Again, Infantrymen (11B) had the highest rates of musculoskeletal-related hospitalizations (total annual average rate per 100,000 11B population = 1,222) with Chemical Operations Specialists (54B) having the next highest average annual rate of musculoskeletal hospitalizations (1,213 per 100,000 54B population) compared to other heavy occupations. Petroleum Supply Specialists (77F) and Unit Supply Specialists (92Y) generally had higher rates of experiencing any hospitalization compared to other heavy physical demand occupations (average annual rates=10,319 per 100,000 77F population and 10,223 per 100,000 92Y population).

Moderate Physical Demands

For Soldiers with moderately physically demanding jobs, Multiple Rocket Launch System Crewmembers (13M) had higher rates of injury hospitalizations than other moderate demands MOSs throughout most of the study period, particularly in the early 1990s and from 2002 forward. On the whole, rates of musculoskeletal hospitalizations among the moderate physical demands group mirrored patterns within the heavy physical demands group – steadily increasing until 1996, and then a relatively sharp decline. From 1980-1991, Medical Specialists (91B) had the highest rates of musculoskeletal hospitalizations with a rate of 1,715 per 100,000 91B population for that 12 year period. Overall hospitalization rates for Medical laboratory Specialists (91K) were higher, on average, than other moderate demand MOSs throughout the study period (13,173 per 100,000 91K population) and were particularly higher than other moderate occupations from 1981-1996.

Light Physical Demands

Within light physical demand occupations, Human Intelligence Collectors (97E) had much higher rates of injury hospitalizations throughout the entire study period than other light demands jobs, with an average annual rate of 9,154 per 100,000 97E

population compared to a combined average annual rate for all other light physical demanding occupations of 841 per 100,000 MOS population. Operating Room Specialists (91D) and Patient Administration Specialists (71G) had higher rates of musculoskeletal hospitalizations, as well as higher rates of hospitalizations overall (all-cause) compared to the rest of the light occupations.

Table 6. Rates of Injury Hospitalizations for Top 15 Heavy MOS Codes, 1980-2006.

Year	Rate 11B Injury Hospitalizations per MOS pop	Rate 11C Injury Hospitalizations per MOS pop	Rate 11M Injury Hospitalizations per MOS pop	Rate 12B Injury Hospitalizations per MOS pop	Rate 13B Injury Hospitalizations per MOS pop	Rate 19D Injury Hospitalizations per MOS pop	Rate 19K Injury Hospitalizations per MOS pop	Rate 31R Injury Hospitalizations per MOS pop	Rate 54B Injury Hospitalizations per MOS pop	Rate 63B Injury Hospitalizations per MOS pop	Rate 77F Injury Hospitalizations per MOS pop	Rate 88M Injury Hospitalizations per MOS pop	Rate 92A Injury Hospitalizations per MOS pop	Rate 92G Injury Hospitalizations per MOS pop	Rate 92Y Injury Hospitalizations per MOS pop
1980	1493.88	1373.22	-	1396.49	1147.75	1293.79	-	1043.65	-	1062.81	935.55	910.05	-	-	860.66
1981	2991.68	2663.09	-	2529.04	2270.88	2789.84	-	1961.17	-	1990.87	1840.49	2250.59	-	-	1414.80
1982	2782.69	2488.70	-	2789.12	2186.97	2518.59	1645.06	1525.34	-	1989.47	1352.51	2034.20	-	-	1724.01
1983	2395.02	2094.42	1122.99	2369.06	2285.38	2128.61	1745.95	1960.22	-	1701.13	1489.91	2059.03	-	-	1406.90
1984	2422.47	2570.16	1923.08	2221.98	2285.66	2378.76	2143.21	1802.91	-	1732.66	1873.54	1870.88	-	-	1420.28
1985	2601.84	2495.99	1835.82	2632.91	2233.31	2235.38	2065.01	1487.66	-	1836.62	2046.20	1935.87	-	-	1285.05
1986	2380.99	2175.78	2173.23	2187.52	2050.93	2000.61	1854.93	1629.76	-	1872.70	1644.85	2000.22	-	-	1371.27
1987	2473.26	1858.08	1828.95	2373.80	1988.28	1880.34	2023.32	1919.18	1071.63	1560.10	1816.98	1782.53	-	-	1339.51
1988	2410.58	2291.17	1602.30	2067.56	2069.20	1828.63	1998.48	1643.60	1452.64	1414.00	1847.33	1763.82	-	-	1435.27
1989	2761.82	2332.52	1878.79	2049.72	1902.82	1523.83	1878.23	1536.02	1585.06	1762.94	1747.30	1482.85	-	-	1135.88
1990	2510.00	2219.87	2706.19	2801.23	1975.90	2741.33	2501.15	1494.77	2101.08	1675.75	1960.60	2618.55	-	-	1408.26
1991	2232.44	1770.55	1963.93	2155.58	1792.59	1817.25	1928.68	1266.94	1670.32	1356.70	1611.13	1712.60	-	-	1126.95
1992	1708.42	1328.39	1264.12	1450.31	1333.92	1509.23	1378.68	905.12	1187.23	941.10	941.15	1045.35	-	-	866.38
1993	2007.29	1654.91	1369.22	1158.04	1632.12	1408.60	1265.67	959.05	1056.47	1077.84	1136.36	1198.51	591.72	-	932.43
1994	1595.22	1353.97	1169.92	1188.29	1425.58	1221.49	1244.32	776.20	1100.80	1073.53	1088.26	855.72	880.24	-	835.67
1995	1437.70	1206.61	1158.03	1299.62	1251.54	1017.03	1002.59	899.21	1036.61	1027.08	1077.51	1003.09	967.05	142.11	797.72
1996	1358.44	1018.62	959.52	1299.30	1148.39	1091.55	1224.26	745.98	824.46	785.96	824.56	826.77	822.91	643.30	665.30
1997	886.32	1102.94	959.33	1135.13	970.12	1088.29	954.34	860.48	724.53	710.49	881.80	668.42	689.79	682.74	593.97
1998	994.03	807.60	1114.43	940.85	864.68	855.33	1086.53	757.85	682.55	523.68	782.72	628.68	627.44	776.95	622.06
1999	1000.34	1198.66	955.37	865.43	891.70	1019.92	789.53	898.13	925.30	667.37	732.71	546.61	693.70	699.18	562.12
2000	955.47	1223.08	1250.81	1258.51	1004.56	1016.46	1092.98	747.16	615.38	713.40	701.31	946.49	608.99	850.84	573.95
2001	1244.95	874.59	1041.76	1122.25	1010.61	997.40	1068.14	559.53	669.70	742.10	555.84	771.25	671.58	859.43	603.99
2002	1088.01	933.83	605.65	930.36	1049.33	1187.35	1122.70	670.80	822.83	955.81	776.06	740.74	529.43	766.07	719.24
2003	2316.17	1902.82	-	2747.50	2139.78	2911.22	2091.75	886.75	1129.94	1137.69	1181.35	1590.96	896.98	1137.07	944.94
2004	2578.26	2151.88	-	2547.37	1957.22	2399.42	2072.10	970.62	1037.86	909.23	1339.36	1511.97	839.72	836.47	789.28
2005	2251.75	1825.07	-	2348.18	1634.36	1613.16	2793.01	1007.13	847.46	794.17	761.87	1118.19	767.14	675.30	553.67
2006	1458.52	1382.93	-	1590.39	985.99	1841.88	1236.05	499.81	469.17	498.60	420.59	563.30	407.03	395.87	343.74

Table 7. Rates of Musculoskeletal Hospitalizations for Top 15 Heavy MOS Codes, 1980-2006.

Year	Rate 11B Musculoskeletal Hosps. per MOS pop	Rate 11C Musculoskeletal Hosps. per MOS pop	Rate 11M Musculoskeletal Hosps. per MOS pop	Rate 12B Musculoskeletal Hosps. per MOS pop	Rate 13B Musculoskeletal Hosps. per MOS pop	Rate 19D Musculoskeletal Hosps. per MOS pop	Rate 19K Musculoskeletal Hosps. per MOS pop	Rate 31R Musculoskeletal Hosps. per MOS pop	Rate 54B Musculoskeletal Hosps. per MOS pop	Rate 63B Musculoskeletal Hosps. per MOS pop	Rate 77F Musculoskeletal Hosp per MOS pop	Rate 88M Musculoskeletal Hosps. per MOS pop	Rate 92A Musculoskeletal Hosps. per MOS pop	Rate 92G Musculoskeletal Hosps. per MOS pop	Rate 92Y Musculoskeletal Hosps. per MOS pop
1980	632.46	543.32	-	515.87	591.27	437.90	-	551.93	-	499.59	571.73	560.03	-	-	556.46
1981	1217.00	896.42	-	900.90	950.99	882.50	-	985.51	-	1075.07	1208.95	1255.98	-	-	1108.61
1982	1162.28	1079.11	-	1150.79	867.80	964.72	1096.71	682.14	-	1168.53	992.98	1186.32	-	-	1093.45
1983	1267.54	1104.45	588.24	1069.90	984.28	814.10	860.32	956.21	-	1200.60	1041.33	1148.02	-	-	1204.39
1984	1468.84	1342.28	1012.15	1370.77	940.97	1158.69	1013.46	849.54	-	1265.39	1068.50	1099.46	-	-	1017.18
1985	1384.39	1265.82	1281.61	1161.41	1049.82	1028.12	1039.17	816.40	-	1272.36	1135.31	1181.45	-	-	1268.93
1986	1600.98	1336.01	1328.96	1353.10	1194.46	1282.83	1093.43	880.73	-	1470.87	883.97	1246.98	-	-	1221.53
1987	1672.08	1221.02	1171.05	1293.75	1120.43	1196.58	1218.50	1355.75	676.82	1560.10	1176.80	1347.26	-	-	1382.72
1988	1811.86	1417.49	1166.99	1562.69	1174.33	1689.31	1211.78	1412.92	1371.94	1583.34	1237.36	1426.55	-	-	1410.38
1989	1843.36	1726.79	1272.73	1722.46	1397.59	1304.93	1430.48	1631.36	1924.71	1576.47	1703.40	1430.20	-	-	1532.81
1990	2045.57	1556.79	1314.94	1599.11	1434.96	1153.36	1465.84	1956.79	2285.05	2019.84	1719.01	2223.39	-	-	1685.37
1991	2136.63	1667.01	1283.47	1743.21	1514.61	1475.98	1370.00	1355.33	2129.66	2061.61	1721.20	1680.49	-	-	1728.30
1992	1895.71	1412.16	1179.84	1635.15	1373.86	1447.09	1485.97	1680.94	1786.30	1516.48	1447.93	1657.96	-	-	1554.53
1993	1936.28	1231.56	1580.77	1473.09	1512.95	1629.35	1737.19	1477.45	1894.35	1800.10	1680.87	1701.34	913.53	-	1494.13
1994	1905.48	1851.34	1442.90	1632.69	1664.15	1729.54	1448.42	1649.42	2053.18	2035.37	1494.86	1815.61	1307.96	-	1572.00
1995	2012.79	1996.13	1757.22	1827.60	1456.23	1394.13	1462.89	1348.82	2375.02	2256.97	1530.55	1840.26	1786.26	757.93	1842.36
1996	1730.29	1416.52	1571.21	1473.14	1507.67	1126.76	1460.18	1361.08	1708.89	1691.23	1226.00	1772.80	1633.07	776.40	1516.12
1997	662.38	767.26	627.49	671.99	717.05	843.73	755.52	516.29	710.33	822.68	619.36	692.29	613.14	527.18	540.58
1998	560.10	570.07	610.14	521.66	432.34	488.76	605.07	553.35	762.85	729.98	386.41	541.14	521.76	420.85	483.83
1999	518.47	495.45	483.97	649.07	388.69	450.66	547.13	590.20	489.86	488.32	340.56	443.20	390.63	409.28	498.08
2000	683.36	637.38	496.45	586.16	438.97	541.38	616.75	453.64	802.68	597.08	393.16	611.58	450.12	567.23	533.90
2001	472.22	577.56	447.77	634.72	530.57	596.27	592.55	611.58	535.76	703.85	555.84	589.35	395.05	594.99	448.32
2002	441.25	322.01	370.12	469.79	446.17	472.84	422.01	518.92	552.84	603.26	476.86	568.65	515.68	442.27	485.80
2003	496.46	543.66	-	495.45	552.20	452.63	594.25	494.05	454.43	670.15	532.06	840.09	441.70	618.81	492.16
2004	503.34	586.88	-	543.92	627.63	456.16	616.24	432.84	672.25	588.93	513.13	818.98	559.81	606.25	563.77
2005	612.44	435.21	-	593.79	608.54	608.89	813.91	480.32	670.90	637.36	664.42	565.60	648.58	635.10	588.28
2006	317.41	262.76	-	282.74	354.61	296.57	396.64	461.36	402.14	329.17	143.00	379.25	407.03	370.05	350.61

Table 8. Rates of Any Hospitalizations for Top 15 Heavy MOS Codes, 1980-2006.

Year	Rate 11B Any Hospitalization per MOS pop	Rate 11C Any Hospitalization per MOS pop	Rate 11M Any Hospitalization per MOS pop	Rate 12B Any Hospitalization per MOS pop	Rate 13B Any Hospitalization per MOS pop	Rate 19D Any Hospitalization per MOS pop	Rate 19K Any Hospitalization per MOS pop	Rate 31R Any Hospitalization per MOS pop	Rate 54B Any Hospitalization per MOS pop	Rate 63B Any Hospitalization per MOS pop	Rate 77F Any Hospitalization per MOS pop	Rate 88M Any Hospitalization per MOS pop	Rate 92A Any Hospitalization per MOS pop	Rate 92G Any Hospitalization per MOS pop	Rate 92Y Any Hospitalization per MOS pop
1980	6527.02	5839.15	-	6768.80	5286.62	6210.19	-	6532.87	-	5972.76	7830.91	6730.84	-	-	6536.58
1981	10518.94	9376.43	-	10072.72	8782.32	9358.76	-	10387.31	-	9194.77	12811.26	11846.97	-	-	10797.49
1982	9905.93	9105.01	-	9886.62	8757.43	8940.28	7178.46	10165.80	-	9543.51	12104.09	10331.31	-	-	12042.57
1983	9100.24	8216.04	4652.41	8700.25	9255.33	8805.74	7793.52	10174.03	-	8917.82	11326.50	10376.62	-	-	11063.35
1984	9495.82	9205.31	6452.43	9468.27	8735.73	8977.90	6778.53	9807.44	-	8891.84	11241.22	9725.68	-	-	10981.77
1985	9763.16	8744.87	7083.48	9178.55	8444.18	8949.30	6554.76	9715.17	-	9522.40	11696.37	10188.25	-	-	11118.27
1986	10018.59	9380.67	8864.92	10537.29	9066.75	9445.63	7693.06	11235.49	-	10728.23	11838.42	11269.69	-	-	11904.01
1987	10366.32	9246.15	8552.63	11187.48	9173.93	9179.49	8597.22	12580.33	7858.62	10504.41	13424.97	11304.56	-	-	12754.84
1988	10606.25	9654.99	7400.20	9712.71	9334.97	9613.38	8958.25	11716.65	10622.42	11108.76	13375.74	11590.17	-	-	12635.33
1989	10966.55	9872.53	8515.15	10903.14	9904.53	9378.68	8786.42	12351.69	13539.01	11704.88	14575.47	11827.67	-	-	13208.34
1990	11515.05	9753.99	10507.78	11764.05	10239.05	9644.80	9922.61	13860.58	13942.68	12570.38	15749.86	16263.57	-	-	15399.99
1991	11194.79	9008.08	8431.07	10652.92	9379.90	8574.35	8730.08	11063.64	12725.75	11336.42	13449.41	14166.44	-	-	14517.73
1992	9349.51	7467.69	6725.10	9028.86	8418.87	8132.10	8400.84	9988.69	11970.37	9703.53	11873.00	11476.42	-	-	12347.15
1993	9432.85	7722.90	7739.32	8148.84	9305.70	8062.65	8177.19	11067.91	10856.10	10083.89	12488.16	11819.81	8169.83	-	11992.36
1994	9007.70	7723.13	7660.17	8008.89	8501.11	7945.09	7288.17	11448.90	10303.03	10363.02	12676.39	11355.01	12093.97	-	11226.04
1995	8109.77	7582.30	7973.73	8559.24	7754.84	6810.65	7453.18	9010.87	10457.95	9976.45	12085.22	11222.57	13341.55	7200.38	11845.52
1996	7299.01	5952.57	6230.88	8015.37	7326.62	6032.86	6484.73	7891.64	9368.91	8835.09	9601.82	10406.23	12694.56	8573.65	10030.71
1997	3867.02	4156.01	5068.18	4785.69	4506.15	4658.84	4161.97	6293.79	5682.63	5706.38	8398.07	6692.13	9337.68	8339.82	7474.64
1998	3603.74	3737.13	4675.63	4136.00	3458.71	3885.63	4007.81	5774.09	6089.40	5054.35	8382.05	5833.20	8480.29	7745.22	7444.01
1999	3723.81	3979.54	4098.05	4335.79	3711.61	4305.03	3933.79	6530.66	6477.07	4826.24	7647.06	6071.80	8324.35	8023.53	7513.88
2000	3784.79	4237.73	4480.98	5025.43	4052.00	4607.23	4777.89	5390.26	6354.52	4807.69	6991.82	7331.63	8618.52	8348.84	7014.15
2001	4035.35	4174.92	4806.73	5050.13	4101.40	4520.82	4787.15	5283.02	6710.42	5034.04	6710.46	6264.55	9020.28	7875.38	7546.70
2002	4241.22	4347.13	3398.38	4661.02	4643.48	4591.78	5223.35	5758.76	6595.53	5625.20	7255.73	7205.39	9907.87	9161.27	8656.15
2003	5972.77	5317.70	-	6287.72	6091.46	6820.29	6465.41	6004.56	6963.89	5758.59	7962.85	8742.84	9119.33	9823.64	9442.88
2004	6146.91	6206.65	-	6527.06	5764.31	6368.03	6316.44	6400.84	6179.97	4272.36	7244.74	7776.84	8383.87	8617.91	8005.57
2005	6261.96	5110.21	-	6414.75	5546.38	6468.45	7753.60	5608.92	6756.12	5275.94	6599.93	7346.25	9045.26	8987.86	8360.44
2006	3637.58	3512.65	-	3984.80	3528.80	4542.26	3855.73	3114.19	3675.16	2991.58	3272.21	3736.75	5048.56	4302.93	4166.09

Table 9. Rates of Injury Hospitalizations for Top 15 Moderate MOS Codes, 1980-2006.

Year	Rate 13M Injury Hospitalization per MOS pop	Rate 14T Injury Hospitalization per MOS pop	Rate 31P Injury Hospitalization per MOS pop	Rate 31S Injury Hospitalization per MOS pop	Rate 31U Injury Hospitalization per MOS pop	Rate 35E Injury Hospitalization per MOS pop	Rate 67R Injury Hospitalization per MOS pop	Rate 74C Injury Hospitalization per MOS pop	Rate 75B Injury Hospitalization per MOS pop	Rate 75H Injury Hospitalization per MOS pop	Rate 88N Injury Hospitalization per MOS pop	Rate 91B Injury Hospitalization per MOS pop	Rate 91K Injury Hospitalization per MOS pop	Rate 95B Injury Hospitalization per MOS pop	Rate 98C Injury Hospitalization per MOS pop
1980	-	-	-	350.26	-	-	-	-	792.60	-	-	1088.79	919.46	820.37	857.84
1981	-	-	-	1044.78	-	-	-	-	1327.18	-	-	2004.43	1209.96	1817.95	1994.63
1982	-	-	-	838.32	-	-	-	-	1296.25	-	-	1810.01	1409.44	1572.79	1679.54
1983	1910.83	-	-	635.79	-	-	-	-	1374.39	-	-	1803.56	1195.76	1558.90	1340.18
1984	2163.23	-	-	1408.45	-	-	-	-	1113.35	-	-	1619.74	1387.87	1626.42	1634.08
1985	2992.35	-	-	1000.67	-	-	3555.56	-	1156.63	-	-	1606.87	1239.83	1769.94	1360.35
1986	1233.91	-	477.33	1581.84	-	-	1452.28	-	1057.93	-	-	1474.37	1101.32	1520.82	1259.60
1987	1556.42	-	560.75	775.80	-	-	1796.41	-	1139.17	-	1672.73	1360.08	1006.47	1508.00	1186.39
1988	1420.56	-	956.02	1853.34	-	-	918.27	-	980.99	-	896.46	1142.93	1067.62	1613.56	890.04
1989	1673.36	-	971.92	815.66	-	-	678.73	-	864.01	-	939.77	1245.53	1159.42	1675.23	668.21
1990	1740.93	-	1155.46	1217.39	-	-	2369.98	-	1288.24	-	1493.19	1646.47	1611.05	1581.59	1026.99
1991	1394.99	-	1200.69	370.37	-	-	1285.05	-	838.90	-	1175.41	1107.35	1009.35	1423.88	1173.88
1992	1164.45	-	636.94	903.41	-	-	838.93	-	815.22	-	805.31	991.06	905.14	978.25	686.20
1993	1717.60	-	431.30	488.83	462.11	-	1080.77	-	769.35	-	783.70	1254.33	544.27	1076.08	848.26
1994	1341.97	-	720.07	652.17	894.65	-	951.32	-	966.65	-	892.39	1093.93	476.36	991.64	902.06
1995	1555.61	-	790.68	644.78	1073.64	804.51	1251.42	443.13	742.31	-	533.33	1018.00	786.22	1002.51	426.89
1996	721.86	-	563.38	739.77	971.28	659.63	1757.28	795.91	920.81	432.25	681.43	887.07	675.14	746.07	522.00
1997	735.12	1075.27	1026.69	546.45	616.38	652.74	600.76	340.77	585.98	286.09	555.56	636.69	377.68	569.80	450.28
1998	656.90	969.83	275.79	327.73	651.69	498.41	623.05	402.82	830.52	488.28	348.63	707.67	306.61	767.52	376.22
1999	708.62	851.37	278.55	524.93	585.32	523.83	652.99	531.31	559.37	383.60	330.76	709.64	331.60	614.04	712.03
2000	767.05	1215.15	837.52	135.07	741.45	334.13	559.44	823.94	747.66	418.36	355.69	819.41	653.29	774.90	510.81
2001	993.75	824.61	398.86	300.56	676.34	376.47	820.42	557.62	928.13	395.07	545.91	731.15	535.95	697.36	737.74
2002	966.73	1030.26	561.48	276.24	754.98	1180.74	697.17	923.55	581.24	595.67	667.35	741.29	806.11	783.52	547.65
2003	1743.70	1077.73	721.15	681.56	1253.57	1088.93	1072.28	625.36	286.40	277.26	693.07	1030.37	671.42	1610.78	466.51
2004	1544.20	1074.19	461.74	404.56	1018.38	1173.02	590.41	259.40	655.42	-	762.20	1220.47	347.07	1360.15	429.65
2005	1113.79	1291.13	852.71	781.25	615.52	816.33	860.83	1044.18	712.82	-	503.89	1037.42	637.81	1501.87	553.93
2006	593.47	285.41	556.59	275.96	397.81	500.94	662.94	486.85	360.40	-	204.50	593.50	474.61	967.86	200.00

Table 10. Rates of Musculoskeletal Hospitalizations for Top 15 Moderate MOS Codes, 1980-2006.

Year	Rate 13M Musculoskeletal Hosps. per MOS pop	Rate 14T Musculoskeletal Hosps. per MOS pop	Rate 31P Musculoskeletal Hosps. per MOS pop	Rate 31S Musculoskeletal Hosps. per MOS pop	Rate 31U Musculoskeletal Hosps. per MOS pop	Rate 35E Musculoskeletal Hosps. per MOS pop	Rate 67R Musculoskeletal Hosps. per MOS pop	Rate 74C Musculoskeletal Hosps. per MOS pop	Rate 75B Musculoskeletal Hosps. per MOS pop	Rate 75H Musculoskeletal Hosps. per MOS pop	Rate 88N Musculoskeletal Hosps. per MOS pop	Rate 91B Musculoskeletal Hosps. per MOS pop	Rate 91K Musculoskeletal Hosps. per MOS pop	Rate 95B Musculoskeletal Hosps. per MOS pop	Rate 98C Musculoskeletal Hosps. per MOS pop
1980	-	-	-	350.26	-	-	-	-	396.30	-	-	772.42	514.90	501.34	245.10
1981	-	-	-	447.76	-	-	-	-	1067.51	-	-	1417.14	747.33	969.15	843.88
1982	-	-	-	598.80	-	-	-	-	850.66	-	-	1379.79	1057.08	987.56	1142.09
1983	636.94	-	-	999.09	-	-	-	-	1057.22	-	-	1498.83	1332.42	1033.62	1083.55
1984	98.33	-	-	815.42	-	-	-	-	992.62	-	-	1412.56	1351.35	1105.17	1371.46
1985	974.25	-	-	733.82	-	-	444.44	-	933.67	-	-	1749.94	1046.11	1163.29	1215.63
1986	536.48	-	0.00	1375.52	-	-	1659.75	-	1120.91	-	-	1866.63	1211.45	1233.37	1290.32
1987	1634.24	-	841.12	930.95	-	-	1946.11	-	1444.51	-	727.27	2349.22	1473.76	1415.05	1280.05
1988	1532.71	-	573.61	1047.54	-	-	642.79	-	1937.75	-	1389.51	1909.37	1672.60	1470.89	1751.36
1989	1506.02	-	971.92	1060.36	-	-	1734.54	-	1753.07	-	1537.80	2014.05	1557.97	1531.35	1542.02
1990	1091.77	-	735.29	782.61	-	-	1777.49	-	1704.24	-	2108.04	2239.20	1956.27	1690.66	1862.91
1991	1627.49	-	1715.27	1111.11	-	-	2453.27	-	1194.37	-	1989.15	1976.31	1757.01	1918.29	1393.98
1992	1782.32	-	1447.60	2084.78	-	-	1845.64	-	1830.66	-	1421.13	1641.44	1846.49	1507.26	2058.59
1993	1784.52	-	1848.43	1675.98	970.43	-	1478.95	-	1617.21	-	2351.10	2010.30	1523.95	1820.34	1665.10
1994	1341.97	-	1080.11	1449.28	1206.27	-	1510.91	-	1498.31	-	2152.23	2055.83	2088.68	1922.88	1288.66
1995	1892.66	-	1373.28	1055.10	1640.84	643.60	1763.37	1299.85	1767.41	-	2453.33	2071.11	1797.08	1951.69	1316.26
1996	1917.44	-	1361.50	1305.48	1477.58	703.61	1702.36	1108.58	1391.45	605.14	1646.79	1705.09	1389.99	1680.00	1715.14
1997	829.97	501.79	821.36	672.55	574.59	696.26	928.45	774.47	428.22	512.58	611.11	773.83	377.68	940.17	750.47
1998	707.43	826.15	275.79	286.77	393.26	634.35	830.74	369.25	415.26	542.53	1336.43	554.93	657.03	767.52	639.58
1999	538.55	780.42	278.55	481.19	461.50	733.37	419.78	341.56	533.94	526.09	551.27	553.73	663.19	633.03	356.01
2000	710.23	750.54	279.17	360.20	571.97	525.06	559.44	303.56	303.74	610.58	558.94	637.32	699.95	631.17	589.39
2001	425.89	983.19	398.86	300.56	545.43	705.88	501.37	418.22	475.96	526.76	545.91	611.03	357.30	666.50	479.53
2002	540.23	450.74	449.19	355.17	571.95	544.96	392.16	461.78	766.18	583.52	616.02	706.47	381.84	641.06	620.66
2003	498.20	653.17	600.96	302.92	461.84	680.58	516.28	568.50	304.31	0.00	396.04	632.68	335.71	630.55	299.90
2004	745.47	637.80	593.67	441.34	475.98	488.76	369.00	843.06	431.62	-	609.76	721.78	433.84	609.72	787.68
2005	752.56	832.99	465.12	603.69	681.47	932.94	717.36	562.25	491.60	-	458.09	833.41	683.37	794.76	586.51
2006	494.56	321.08	185.53	379.44	354.80	250.47	488.49	389.48	360.40	-	531.70	367.80	474.61	357.81	166.67

Table 11. Rates of Any Hospitalizations for Top 15 Moderate MOS Codes, 1980-2006.

Year	Rate 13M Any Hospitalization per MOS pop	Rate 14T Any Hospitalization per MOS pop	Rate 31P Any Hospitalization per MOS pop	Rate 31S Any Hospitalization per MOS pop	Rate 31U Any Hospitalization per MOS pop	Rate 35E Any Hospitalization per MOS pop	Rate 67R Any Hospitalization per MOS pop	Rate 74C Any Hospitalization per MOS pop	Rate 75B Any Hospitalization per MOS pop	Rate 75H Any Hospitalization per MOS pop	Rate 88N Any Hospitalization per MOS pop	Rate 91B Any Hospitalization per MOS pop	Rate 91K Any Hospitalization per MOS pop	Rate 95B Any Hospitalization per MOS pop	Rate 98C Any Hospitalization per MOS pop
1980	-	-	-	5779.33	-	-	-	-	6384.85	-	-	9597.76	7686.65	5305.06	6944.44
1981	-	-	-	9253.73	-	-	-	-	10588.57	-	-	15137.46	14982.21	9067.59	11660.91
1982	-	-	-	9580.84	-	-	-	-	10572.51	-	-	14325.03	15891.47	9137.46	10816.26
1983	10615.71	-	-	8446.87	-	-	-	-	11285.85	-	-	14913.90	14485.82	10268.40	9124.61
1984	6588.00	-	-	7412.90	-	-	-	-	10301.81	-	-	12844.90	16106.65	9742.02	11934.64
1985	10229.65	-	-	6871.25	-	-	14222.22	-	11594.20	-	-	12854.94	15691.59	9889.67	10535.46
1986	6384.12	-	4295.94	9353.51	-	-	10165.98	-	12518.89	-	-	13161.10	14977.97	10110.97	11305.68
1987	8715.95	-	7196.26	7680.37	-	-	10628.74	-	14327.66	-	9309.09	13738.15	18008.63	10838.35	11863.88
1988	8710.28	-	6978.97	9105.56	-	-	7805.33	-	13891.24	-	12998.66	13500.07	19466.19	11712.75	11053.69
1989	9672.02	-	7559.40	8075.04	-	-	8823.53	-	14237.42	-	16915.85	14999.34	20688.41	11315.52	11256.75
1990	8793.15	-	8718.49	12434.78	-	-	10928.24	-	14881.91	-	17918.31	15318.76	21020.33	12016.43	12037.26
1991	9325.76	-	10034.31	8962.96	-	-	10922.90	-	12370.25	-	15867.99	13226.70	18317.76	11450.38	11371.97
1992	8626.43	-	7064.27	8825.57	-	-	7941.83	-	11985.13	-	14542.87	12821.80	18356.26	9849.69	10504.09
1993	10394.82	-	8256.32	7611.73	6869.99	-	9442.55	-	10613.91	-	14106.58	15288.45	17271.41	10173.03	10681.75
1994	7519.67	-	7335.73	7608.70	8534.38	-	8561.84	-	11438.70	-	14068.24	13900.41	17845.36	10147.99	9246.13
1995	8478.09	-	7615.48	8206.33	9227.19	6516.49	9328.78	7444.61	10851.89	-	14080.00	13655.28	15200.30	10110.38	9178.23
1996	6451.61	-	8779.34	7267.19	8534.82	6860.16	8347.06	11512.22	10190.30	5295.01	12208.97	12376.50	14376.49	7557.30	8948.55
1997	4553.00	7096.77	6211.50	5212.27	5975.76	5221.93	5625.34	7930.61	6851.48	6246.27	10166.67	8115.39	7385.65	5213.68	5178.24
1998	3663.47	6285.92	4136.79	4711.18	4921.35	4349.80	4153.69	6747.23	7889.96	6792.53	9471.24	8140.72	7358.74	5324.70	4364.18
1999	3628.12	8052.50	5069.64	4855.64	5020.26	4662.13	5223.88	7134.72	7348.08	6882.95	6890.85	8338.26	6489.82	5652.97	4944.62
2000	4318.18	8434.60	5583.47	3511.93	4946.51	3723.15	4475.52	7285.34	7920.56	7417.46	6961.38	8419.02	7466.17	5774.28	5108.06
2001	4287.34	7928.96	5584.05	4036.07	5421.62	5411.76	3919.78	6459.11	9233.70	8188.67	8039.70	7943.39	8530.59	5659.10	4869.05
2002	4435.60	9111.40	6007.86	3946.33	5765.27	4586.74	4793.03	8876.35	9881.11	7986.87	7546.20	8467.66	7679.25	5906.10	4819.28
2003	5978.41	7968.65	5709.13	4240.82	6443.81	7395.64	5599.68	6424.10	5835.50	3696.86	8316.83	9060.92	8057.07	7360.28	4665.11
2004	5138.45	6747.23	4089.71	5296.06	5501.44	5865.10	4944.65	6809.34	7625.29	-	6656.50	8425.20	8590.02	6607.26	5119.94
2005	6261.29	8371.51	6744.19	4332.39	5913.39	4606.41	5451.94	6666.67	7791.89	-	5771.87	8633.56	8382.69	6884.06	5017.92
2006	3461.92	3032.47	2690.17	2000.69	3042.68	2567.31	2896.02	4868.55	4188.69	-	3108.38	4551.53	5363.08	3906.62	2400.00

Table 12. Rates of Injury Hospitalizations for Top 15 Light MOS Codes, 1980-2006.

Year	Rate 14E Injury Hospitalization per MOS pop	Rate 14R Injury Hospitalization per MOS pop	Rate 33W Injury Hospitalization per MOS pop	Rate 71D Injury Hospitalization per MOS pop	Rate 71G Injury Hospitalization per MOS pop	Rate 71L Injury Hospitalization per MOS pop	Rate 73C Injury Hospitalization per MOS pop	Rate 76J Injury Hospitalization per MOS pop	Rate 91D Injury Hospitalization per MOS pop	Rate 91S Injury Hospitalization per MOS pop	Rate 93P Injury Hospitalization per MOS pop	Rate 96B Injury Hospitalization per MOS pop	Rate 96D Injury Hospitalization per MOS pop	Rate 97B Injury Hospitalization per MOS pop	Rate 97E Injury Hospitalization per MOS pop
1980	-	-	-	928.79	739.96	631.75	342.40	642.40	1360.23	242.13	-	821.60	752.82	318.13	8695.65
1981	-	-	-	1116.84	1808.14	1119.18	1016.82	1252.51	1457.45	1169.59	-	1262.83	1480.48	714.92	13043.48
1982	-	-	-	1062.47	1510.57	1069.37	1272.26	1253.76	1723.31	2281.37	-	1225.40	1623.82	985.66	6172.84
1983	-	-	-	1057.08	1564.03	916.11	1041.22	1338.26	1729.11	1077.84	-	1074.90	732.06	1156.07	6122.45
1984	-	-	-	896.67	1586.43	1068.40	1168.01	1300.51	1674.64	1203.37	440.53	1176.47	287.36	764.82	13846.15
1985	-	-	-	830.06	1702.36	1073.52	1167.58	1137.49	2269.13	1566.27	828.03	1572.42	976.29	880.28	11290.32
1986	-	-	-	886.66	1291.99	917.50	1007.50	1527.07	2000.00	1831.90	1369.17	1272.57	944.51	657.41	10429.45
1987	-	-	-	1278.57	1855.57	880.41	948.17	1206.43	1686.75	1416.12	1170.64	1216.41	1605.50	1234.57	11242.60
1988	-	-	-	1124.08	1136.36	965.75	967.25	1565.30	1659.75	1325.97	1466.99	1096.26	1184.60	1369.08	7812.50
1989	-	-	-	936.97	1656.87	742.00	1027.40	1371.16	1678.66	1013.51	1533.22	807.27	862.90	1724.14	7317.07
1990	-	-	-	626.68	1800.33	960.23	1113.26	1941.29	1858.36	1853.87	1498.64	868.52	1090.91	1492.54	7821.23
1991	-	-	-	963.74	1326.70	923.35	1047.38	1381.46	2138.24	1349.95	937.65	901.76	770.71	1526.72	9009.01
1992	-	775.19	-	646.12	910.47	756.80	690.00	911.73	1433.35	1652.89	872.94	864.78	391.39	1033.30	4545.45
1993	-	528.40	-	643.88	1397.33	719.38	552.97	1057.27	989.55	1033.30	963.00	588.90	1315.79	1014.66	5882.35
1994	-	837.21	-	471.20	1134.09	756.36	323.52	841.17	1064.50	833.33	810.95	522.34	704.23	500.56	9909.91
1995	-	1308.26	-	689.66	847.46	785.36	545.65	1206.08	1425.66	814.90	753.65	428.08	818.83	350.06	10869.57
1996	-	561.80	-	491.53	743.19	647.10	623.54	860.22	861.50	383.14	851.47	746.47	865.80	1312.34	8333.33
1997	542.74	684.54	-	478.98	674.37	386.40	507.61	678.73	659.63	904.39	546.20	438.00	328.95	592.11	7142.86
1998	606.06	725.85	-	424.40	654.82	439.01	353.51	793.65	531.11	646.83	564.97	432.90	560.54	147.28	10416.67
1999	1292.78	890.59	195.31	269.69	853.89	433.33	436.11	170.75	862.75	507.61	457.46	503.40	944.39	335.57	9803.92
2000	775.19	538.36	328.14	537.63	93.20	496.96	753.55	419.92	313.48	645.99	1011.49	445.14	277.78	342.47	2040.82
2001	673.40	643.09	488.20	559.60	500.50	461.31	363.47	206.61	711.46	1026.96	988.82	433.20	769.23	586.04	20454.55
2002	884.96	811.12	470.96	331.67	842.99	421.90	727.10	208.33	577.08	1044.39	703.92	453.21	575.26	328.05	9090.91
2003	424.50	1090.25	530.15	520.29	314.14	611.56	719.75	-	485.04	798.93	519.93	375.72	357.78	369.20	11940.30
2004	927.64	2595.80	619.41	533.62	519.75	584.09	353.98	130.98	900.90	262.81	660.19	821.87	285.99	736.31	10769.23
2005	589.10	2211.30	641.03	455.84	509.16	435.41	629.37	700.64	546.88	990.10	570.41	410.54	419.73	1131.73	4687.50
2006	482.51	619.20	200.00	118.62	0.00	261.69	432.12	451.47	79.37	136.80	426.59	324.20	201.41	353.15	8474.58

Table 13. Rates of Musculoskeletal Hospitalizations for Top 15 Light MOS Codes, 1980-2006.

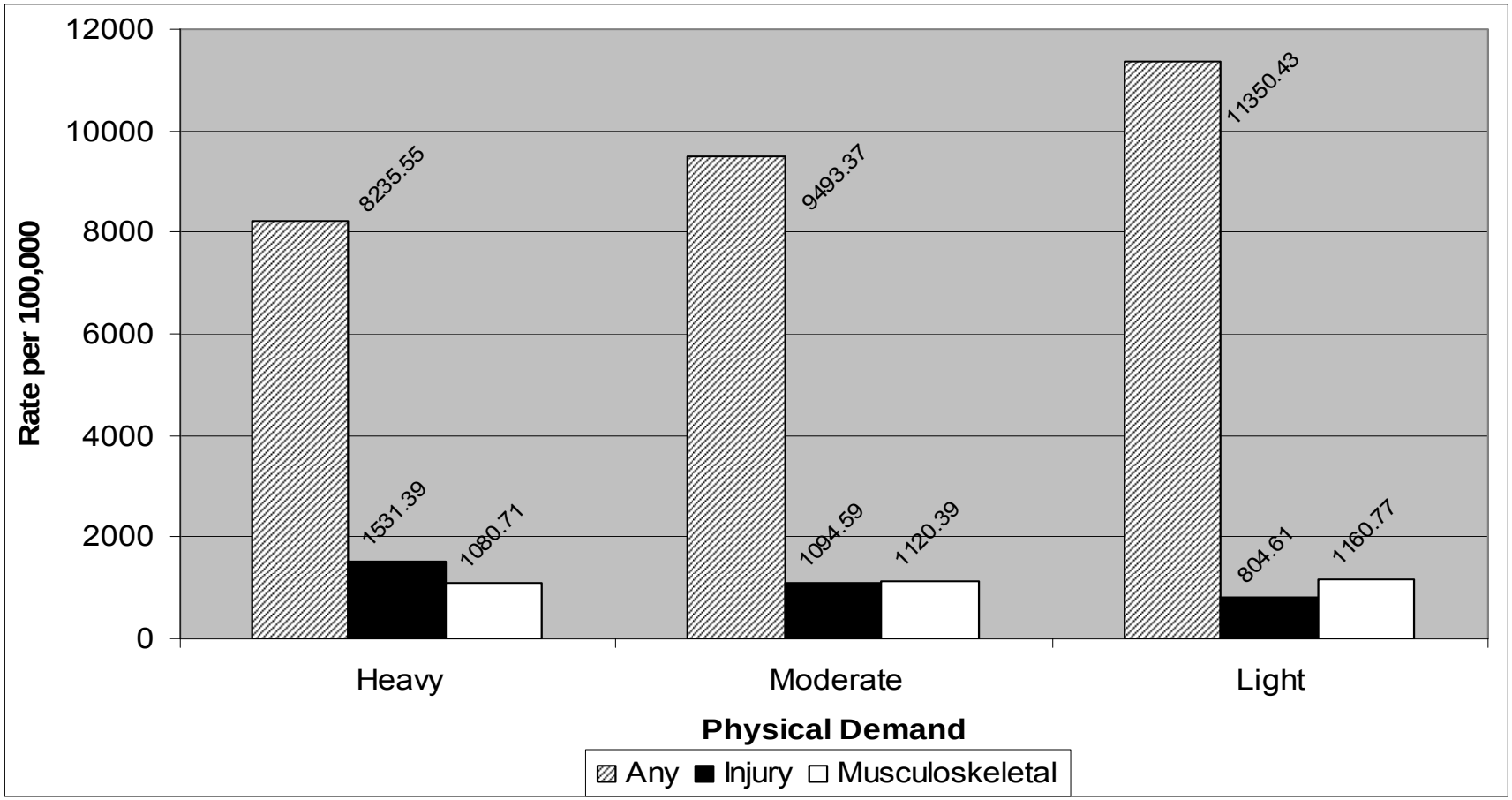
Year	Rate 14E Musculoskeletal Hosps. per MOS pop	Rate 14R Musculoskeletal Hosps. per MOS pop	Rate 33W Musculoskeletal Hosps. per MOS pop	Rate 71D Musculoskeletal Hosps. per MOS pop	Rate 71G Musculoskeletal Hosps. per MOS pop	Rate 71L Musculoskeletal Hosps. per MOS pop	Rate 73C Musculoskeletal Hosps. per MOS pop	Rate 76J Musculoskeletal Hosps. per MOS pop	Rate 91D Musculoskeletal Hosps. per MOS pop	Rate 91S Musculoskeletal Hosps. per MOS pop	Rate 93P Musculoskeletal Hosps. per MOS pop	Rate 96B Musculoskeletal Hosps. per MOS pop	Rate 96D Musculoskeletal Hosps. per MOS pop	Rate 97B Musculoskeletal Hosps. per MOS pop	Rate 97E Musculoskeletal Hosps. per MOS pop
1980	-	-	-	619.20	1532.77	590.48	494.58	642.40	1078.80	605.33	-	586.85	376.41	742.31	725.69
1981	-	-	-	816.15	2461.07	1242.85	1201.70	1553.11	2538.79	701.75	-	907.66	807.54	1161.75	1333.33
1982	-	-	-	1359.97	2215.51	1106.14	861.23	902.71	2441.36	1394.17	-	1299.67	676.59	1881.72	2884.62
1983	-	-	-	1014.80	1661.78	1238.89	1317.47	1384.40	1777.14	1437.13	-	2115.12	1171.30	963.39	1338.83
1984	-	-	-	1280.96	1641.14	1188.22	898.47	1393.40	3062.20	1805.05	881.06	1207.43	862.07	1338.43	1919.72
1985	-	-	-	873.74	1537.62	1243.58	1259.16	1928.78	2532.98	1686.75	1210.19	1270.03	557.88	1144.37	1356.74
1986	-	-	-	1310.72	1757.11	998.35	1136.12	1249.42	3219.51	862.07	1369.17	1805.27	1180.64	1314.83	2139.46
1987	-	-	-	1472.30	3009.03	1328.01	1453.86	1251.12	2795.18	1416.12	1530.84	2149.93	1949.54	1234.57	1879.40
1988	-	-	-	1642.89	2685.95	1375.59	2022.42	1610.02	3042.88	1546.96	1507.74	1978.61	1579.47	1540.22	1766.19
1989	-	-	-	1533.22	2672.37	1564.46	2237.44	1985.82	4028.78	1801.80	1575.81	1992.94	1342.28	1880.88	1625.44
1990	-	-	-	1477.17	2673.21	1606.44	2008.71	2035.98	2913.11	1962.92	2179.84	1785.28	1000.00	1439.23	1848.31
1991	-	-	-	1468.56	2874.52	1851.67	2044.89	2450.98	3431.13	1142.26	1547.12	1850.97	963.39	2344.60	1941.18
1992	-	1550.39	-	1988.07	2883.16	1549.40	1379.99	1906.34	3344.48	1756.20	1357.90	1598.53	2348.34	2296.21	1702.69
1993	-	924.70	-	1040.12	3098.42	1789.68	1571.59	1762.11	4068.17	1951.78	912.32	1906.90	708.50	2649.38	2178.50
1994	-	744.19	-	1675.39	2268.18	1561.92	1747.01	2375.06	3068.25	2619.05	1875.32	1944.28	1106.64	1946.61	1851.85
1995	-	981.19	-	1007.96	3004.62	1659.50	1891.60	2884.11	3258.66	2328.29	2072.54	1655.25	1740.02	1458.58	2074.33
1996	-	842.70	-	1747.68	2064.41	1467.27	1169.13	2365.59	2186.88	1277.14	1655.63	1354.71	2272.73	2559.06	980.39
1997	407.06	684.54	-	691.86	385.36	575.66	507.61	1131.22	1121.37	645.99	591.72	958.12	767.54	657.89	823.42
1998	1136.36	558.35	-	636.60	935.45	376.29	353.51	566.89	455.24	388.10	564.97	676.41	784.75	515.46	596.42
1999	836.50	445.29	292.97	323.62	474.38	425.00	130.83	796.81	549.02	253.81	548.95	629.25	419.73	536.91	313.81
2000	1057.08	269.18	410.17	483.87	745.57	496.96	576.24	419.92	940.44	645.99	643.68	489.65	92.59	513.70	645.16
2001	673.40	707.40	162.73	839.40	1201.20	574.46	90.87	619.83	711.46	770.22	816.85	342.00	480.77	426.21	401.61
2002	707.96	115.87	549.45	608.07	210.75	504.45	339.31	625.00	329.76	783.29	615.93	815.77	383.51	437.40	509.68
2003	1030.93	484.55	331.35	572.32	732.98	516.01	449.84	-	1293.45	532.62	606.59	276.84	357.78	527.43	278.81
2004	742.12	741.66	412.94	693.70	831.60	513.60	389.38	720.37	737.10	394.22	970.87	535.17	285.99	828.35	436.36
2005	1178.20	819.00	569.80	512.82	712.83	616.84	559.44	573.25	703.13	565.77	534.76	342.11	314.80	407.42	384.62
2006	120.63	619.20	333.33	177.94	781.25	279.13	468.13	225.73	555.56	136.80	319.94	340.41	604.23	294.29	129.24

Table 14. Rates of Any Hospitalizations for Top 15 Light MOS Codes, 1980-2006.

Year	Rate 14E Any Hosp per MOS pop	Rate 14R Any Hosp per MOS pop	Rate 33W Any Hosp per MOS pop	Rate 71D Any Hosp per MOS pop	Rate 71G Any Hosp per MOS pop	Rate 71L Any Hosp per MOS pop	Rate 73C Any Hosp per MOS pop	Rate 76J Any Hosp per MOS pop	Rate 91D Any Hosp per MOS pop	Rate 91S Any Hosp per MOS pop	Rate 93P Any Hosp per MOS pop	Rate 96B Any Hosp per MOS pop	Rate 96D Any Hosp per MOS pop	Rate 97B Any Hosp per MOS pop	Rate 97E Any Hosp per MOS pop
1980	-	-	-	5970.81	11205.07	7949.21	6619.75	8832.98	12335.83	9443.10	-	8372.46	8406.52	8165.43	6676.34
1981	-	-	-	11297.25	20090.41	12951.00	11961.55	14779.56	18570.76	14853.80	-	10655.09	8209.96	8310.99	10222.22
1982	-	-	-	11602.21	20896.27	12976.47	13486.01	15245.74	18429.87	15716.10	-	10174.53	11772.67	10663.08	11126.37
1983	-	-	-	11374.21	19452.59	12853.15	14152.15	15182.28	20701.25	13652.69	-	10610.26	9224.01	9730.25	10092.69
1984	-	-	-	11870.20	20623.63	13053.75	13387.24	15606.13	19904.31	15282.79	8810.57	8978.33	6896.55	8699.81	11343.80
1985	-	-	-	11183.92	21142.23	13647.48	12980.77	17161.23	19050.13	14457.83	8089.17	10160.27	7949.79	8978.87	9896.25
1986	-	-	-	13415.57	20000.00	14026.08	13804.93	13836.19	20585.37	16487.07	11206.90	11956.20	10389.61	8619.43	12916.01
1987	-	-	-	14141.81	23119.36	15843.60	15212.81	18811.44	22313.25	18409.59	13372.35	12107.50	13073.39	10246.91	13234.14
1988	-	-	-	14699.52	26446.28	16669.37	15805.67	17531.31	25449.52	15469.61	14180.93	11577.54	11056.27	10781.52	10765.35
1989	-	-	-	13798.98	28968.47	18049.35	16735.16	20803.78	28633.09	17454.95	15715.50	12083.75	13039.31	14158.83	11590.11
1990	-	-	-	14592.66	27114.02	17689.09	15174.25	21543.56	25113.01	18211.56	13941.87	12400.48	11727.27	13699.36	11408.54
1991	-	-	-	14180.82	24599.23	17578.44	15685.79	18226.38	24515.17	13291.80	12751.99	10465.12	12620.42	11668.48	13058.82
1992	-	3100.78	-	13170.97	20940.82	15601.35	13923.11	16493.99	21070.23	18491.74	12415.13	10691.82	13405.09	11595.87	10085.13
1993	-	6472.92	-	10549.78	25030.38	15867.35	13474.97	17004.41	23144.58	16532.72	11758.74	9702.75	10627.53	12965.05	9557.27
1994	-	4372.09	-	12356.02	19346.23	14327.88	12487.87	16674.91	20475.89	13214.29	11150.53	8850.84	10261.57	8453.84	8222.22
1995	-	5805.40	-	10557.03	15331.28	14546.20	12804.66	16203.46	17718.94	16181.61	13283.09	7990.87	9928.35	8226.37	7951.60
1996	-	3581.46	-	11086.84	13294.80	13032.36	11613.41	13494.62	16169.65	11749.68	11447.49	7962.40	9632.03	9580.05	6417.11
1997	3663.50	3536.79	-	7503.99	10693.64	8713.82	8375.63	9276.02	9102.90	7105.94	7510.24	4681.08	6140.35	5131.58	5123.51
1998	6287.88	3964.27	-	7267.90	10196.45	7815.93	7688.91	6292.52	9104.70	7373.87	6450.09	4653.68	5269.06	3092.78	4771.37
1999	6539.92	4643.77	2050.78	6256.74	7969.64	9058.33	6628.87	8252.70	9019.61	6345.18	6450.14	4782.28	3462.75	3758.39	5334.73
2000	6694.86	4306.86	3281.38	6559.14	8667.29	8842.43	8554.96	7918.42	9639.50	5943.15	7126.44	4006.23	3888.89	4509.13	5268.82
2001	4848.48	3987.14	2603.74	7050.92	10710.71	9774.57	8041.80	8539.94	9565.22	8600.77	7781.60	4195.17	5000.00	3462.97	4417.67
2002	5840.71	3939.75	4160.13	7683.80	9799.79	10281.57	9549.20	7916.67	8903.54	5874.67	8754.95	5053.25	5177.37	4483.32	5606.52
2003	6367.50	5996.37	3445.99	7544.22	9319.37	9842.33	8636.98	-	10751.82	8521.97	7885.62	4943.64	4830.05	4219.41	6226.77
2004	6122.45	6365.88	3372.33	8591.25	11122.66	8580.06	6761.06	5435.49	9500.41	7621.55	7844.66	4969.42	4289.80	5062.13	4727.27
2005	5891.02	7043.41	4914.53	7692.31	8044.81	8756.65	8811.19	8343.95	9218.75	7496.46	6737.97	4430.38	3462.75	4391.13	2735.04
2006	1990.35	2941.18	1866.67	3143.53	6835.94	5006.98	4645.30	3950.34	6349.21	2735.98	3697.12	3015.08	2719.03	2589.76	1906.30

Figure 1 displays a summary over the study period comparing risk for each type of hospitalization by occupational demand group. As observed with just the 2000 study population, the overall risk of any-cause hospitalization was greatest among those in the least physically demanding jobs and lowest among those in the heavy-demands MOSs. As hypothesized, Soldiers in heavy demands jobs were at greater risk for injury-related hospitalizations than were Soldiers in moderate or light demands jobs, but they were at lowest risk for musculoskeletal disorders.

Figure 1. Average hospitalization rates for heavy, moderate and light physically demanding jobs, 1980-2006



Tables 15-17 focus more closely on the injury hospitalizations within each physical demand category in order to assess the nature of these injuries. Of all injuries identified in hospitalizations among heavy MOSs, 39% (N=38,193) were sustained either during an on-duty accident or through battle/enemy action. Whereas among moderate-demand MOSs, duty-related injuries accounted for 32% (N=6,596) of the injury hospitalizations and only 26% (N=2,465) of injury hospitalizations among Soldiers in light physically demanding MOSs.

Among heavy physically demanding occupations, 11B (Infantrymen) had the highest percentage of reported “on-duty” injuries (N=12,226; 40.61%). For the moderately physically demanding occupations, 91B (Medical Supply Specialists) had the highest percentage of injuries reported as “on-duty” injuries (N=1,796, 31.27%), and for light demands occupations, 33.85% (N=261) of injuries sustained by Soldiers in 96B (Intelligence Agents) were related to an accident on-duty. The distribution of circumstances under which hospitalized injuries occurred, stratified by job demands, is presented in Tables 15-17.

Table 15. Nature of Injury for Injury-related Hospitalizations among Heavy Physical Demand MOS Codes (N=97,368).

	Nature of Injury									Total
	Enemy Action N Row %	**Other Battle Injuries** N Row %	Legal Intervention N Row %	Assault N Row %	Self-inflicted N Row %	Accidental, off duty N Row %	**Accidental, On Duty** N Row %	Duty Status Unknown N Row %	Missing N Row %	
11B	264 0.87%	1,684 5.58%	30 0.10%	1,523 5.04%	975 3.23%	5,881 19.47%	12,266 40.61%	6,590 21.82%	993 3.29%	30,206 31.02%
11C	23 0.50%	149 3.23%	2 0.04%	268 5.81%	199 4.31%	1,020 22.12%	1,721 37.32%	1,099 23.83%	131 2.84%	4,612 4.74%
11M	6 0.17%	89 2.49%	4 0.11%	178 4.98%	114 3.19%	674 18.84%	1,090 30.47%	1,219 34.08%	203 5.68%	3,577 3.67%
12B	62 0.85%	316 4.33%	5 0.07%	409 5.6%	229 3.14%	1,517 20.78%	2,654 36.36%	1,869 25.61%	238 3.26%	7,299 7.50%
13B	34 0.33%	221 2.15%	4 0.04%	701 6.82%	464 4.52%	2,239 21.79%	3,469 33.76%	2,914 28.36%	229 2.23%	10,275 10.55%
19D	59 1.10%	336 6.28%	6 0.11%	261 4.88%	171 3.20%	987 18.44%	2,025 37.84%	1,278 23.88%	229 4.28%	5,352 5.50%
19K	43 0.82%	292 5.60%	0 0.00%	204 3.91%	142 2.72%	853 16.35%	1,824 34.97%	1,557 29.85%	301 5.77%	5,216 5.36%
31R	2 0.07%	21 0.76%	1 0.04%	164 5.93%	156 5.64%	687 24.86%	760 27.5%	865 31.3%	108 3.91%	2,764 2.84%
54B	2 0.11%	33 1.84%	2 0.11%	67 3.75%	89 4.97%	273 15.26%	498 27.84%	719 40.19%	106 5.93%	1,789 1.84%
63B	10 0.14%	70 0.95%	5 0.07%	384 5.22%	294 3.99%	1,858 25.24%	2,264 30.75%	2,234 30.35%	243 3.30%	7,362 7.56%
77F	5 0.16%	54 1.78%	3 0.10%	157 5.17%	140 4.61%	597 19.67%	964 31.76%	943 31.07%	172 5.67%	3,035 3.12%
88M	17 0.22%	161 2.10%	10 0.13%	419 5.46%	362 4.71%	1,864 24.27%	2,343 30.51%	2,284 29.74%	220 2.86%	7,680 7.89%
92A	5 0.34%	28 1.88%	0 0.00%	47 3.16%	62 4.17%	218 14.66%	419 28.18%	508 34.16%	200 13.45%	1,487 1.53%
92G	7 0.70%	29 2.90%	0 0.00%	30 3.00%	47 4.70%	138 13.79%	276 27.57%	290 28.97%	184 18.38%	1,001 1.03%
92Y	6 0.11%	38 0.67%	0 0.00%	344 6.02%	296 5.18%	1,453 25.43%	1,554 27.20%	1,808 31.65%	214 3.75%	5,713 5.87%
Total	545 0.56%	3,521 3.62%	72 0.07%	5,156 5.30%	3,740 3.84%	20,259 20.81%	34,127 35.05%	26,177 26.88%	3,771 3.87%	

Table 16. Nature of Injury for Injury-related Hospitalizations among Moderate Physical Demand MOS Codes (N=20,821).

	Nature of Injury for Moderate Physically Demanding MOS codes (N=20,821)									Total
	Enemy Action N Row %	**Other Battle Injuries** N Row %	Legal Intervention N Row %	Assault N Row %	Self-inflicted N Row %	Accidental, off duty N Row %	**Accidental, On Duty** N Row %	Duty Status Unknown N Row %	Missing N Row %	
13M	6 0.62%	36 3.70%	0 0.00%	50 5.13%	53 5.44%	149 15.30%	270 27.72%	355 36.45%	55 5.65%	974 4.68%
14T	0 0.00%	0 0.00%	0 0.00%	4 1.53%	7 2.67%	6 2.29%	37 14.12%	154 58.78%	54 20.61%	262 1.26%
31P	0 0.00%	1 0.47%	0 0.00%	8 3.72%	4 1.86%	54 25.12%	42 19.53%	86 40.00%	20 9.30%	215 1.03%
31S	0 0.00%	1 0.32%	0 0.00%	9 2.92%	9 2.92%	76 24.68%	75 24.35%	114 37.01%	24 7.79%	308 1.48%
31U	4 0.41%	27 2.74%	1 0.10%	34 3.45%	34 3.45%	163 16.53%	259 26.27%	359 36.41%	105 10.65%	986 4.74%
35E	1 0.58%	2 1.16%	0 0.00%	8 4.65%	6 3.49%	23 13.37%	47 27.33%	60 34.88%	25 14.53%	172 0.83%
67R	5 1.32%	2 0.53%	0 0.00%	12 3.17%	7 1.85%	95 25.13%	74 19.58%	145 38.36%	38 10.05%	378 1.82%
74C	0 0.00%	0 0.00%	0 0.00%	5 3.09%	13 8.02%	31 19.14%	31 19.14%	44 27.16%	38 23.46%	162 0.78%
75B	1 0.06%	12 0.72%	1 0.06%	77 4.61%	103 6.17%	414 24.79%	426 25.51%	517 30.96%	119 7.13%	1670 8.02%
75H	1 0.41%	0 0.00%	0 0.00%	6 2.44%	5 2.03%	48 19.51%	58 23.58%	96 39.02%	32 13.01%	246 1.18%
88N	0 0.00%	3 1.02%	0 0.00%	9 3.06%	10 3.40%	68 23.13%	75 25.51%	100 34.01%	29 9.86%	294 1.41%
91B	21 0.37%	160 2.79%	3 0.05%	250 4.35%	337 5.87%	1206 21.00%	1796 31.27%	1733 30.17%	238 4.14%	5744 27.59%
91K	0 0.00%	2 0.33%	1 0.17%	18 3.00%	31 5.17%	152 25.33%	132 22.00%	235 39.17%	29 4.83%	600 2.88%
95B	24 0.30%	242 3.00%	7 0.09%	294 3.64%	365 4.53%	1850 22.94%	2536 31.44%	2444 30.30%	304 3.77%	8066 38.74%
98C	0 0.00%	0 0.00%	1 0.13%	18 2.42%	36 4.84%	209 28.09%	187 25.13%	244 32.80%	49 6.59%	744 3.57%
Total	63 0.30%	488 2.34%	14 0.07%	802 3.85%	1020 4.90%	4544 21.82%	6045 29.03%	6686 32.11%	1159 5.57%	

Table 17. Nature of Injury for Injury-related Hospitalizations among Light Physical Demand MOS Codes (N=9,566).

	Nature of Injury for Light Physically Demanding MOS codes (N=9,566)									Total
	Enemy Action N Row %	**Other Battle Injuries** N Row %	Legal Intervention N Row %	Assault N Row %	Self-inflicted N Row %	Accidental, off duty N Row %	**Accidental, On Duty** N Row %	Duty Status Unknown N Row %	Missing N Row %	
14E	0 0.00%	0 0.00%	0 0.00%	0 0.00%	4 3.88%	12 11.65%	14 13.59%	55 53.40%	18 17.48%	103 1.08%
14R	0 0.00%	23 11.50%	0 0.00%	8 4.00%	6 3.00%	18 9.00%	53 26.50%	66 33.00%	26 13.00%	200 2.09%
33W	0 0.00%	0 0.00%	0 0.00%	1 2.13%	1 2.13%	6 12.77%	11 23.40%	10 21.28%	18 38.30%	47 0.49%
71D	0 0.00%	1 0.24%	0 0.00%	14 3.41%	17 4.14%	104 25.30%	112 27.25%	146 35.52%	17 4.14%	411 4.30%
71G	0 0.00%	1 0.21%	1 0.21%	14 2.97%	38 8.05%	111 23.52%	107 22.67%	189 40.04%	11 2.33%	472 4.93%
71L	0 0.00%	5 0.12%	0 0.00%	195 4.63%	273 6.48%	1201 28.5%	954 22.64%	1409 33.44%	177 4.20%	4214 44.05%
73C	1 0.13%	3 0.39%	0 0.00%	26 3.36%	34 4.40%	203 26.26%	193 24.97%	286 37.00%	27 3.49%	773 8.08%
76J	0 0.00%	1 0.20%	0 0.00%	23 4.57%	25 4.97%	102 20.28%	128 25.45%	207 41.15%	17 3.38%	503 5.26%
91D	0 0.00%	3 0.49%	0 0.00%	26 4.27%	40 6.57%	154 25.29%	173 28.41%	205 33.66%	8 1.31%	609 6.37%
91S	0 0.00%	3 1.26%	0 0.00%	6 2.52%	14 5.88%	53 22.27%	65 27.31%	88 36.97%	9 3.78%	238 2.49%
93P	0 0.00%	2 0.46%	0 0.00%	9 2.08%	23 5.32%	105 24.31%	100 23.15%	158 36.57%	35 8.10%	432 4.52%
96B	0 0.00%	11 1.43%	1 0.13%	23 2.98%	21 2.72%	159 20.62%	261 33.85%	251 32.56%	44 5.71%	771 8.06%
96D	0 0.00%	1 0.52%	0 0.00%	5 2.59%	10 5.18%	53 27.46%	55 28.50%	56 29.02%	13 6.74%	193 2.02%
97B	1 0.28%	9 2.51%	0 0.00%	7 1.96%	5 1.40%	77 21.51%	109 30.45%	125 34.92%	25 6.98%	358 3.74%
97E	0 0.00%	0 0.00%	1 0.41%	6 2.48%	10 4.13%	65 26.86%	65 26.86%	83 34.30%	12 4.96%	242 2.53%
Total	2 0.02%	63 0.66%	3 0.03%	363 3.79%	521 5.45%	2423 25.33%	2400 25.09%	3334 34.85%	457 4.78%	

DISCUSSION

As hypothesized, we found that the odds for experiencing an injury hospitalization increased with increasing level of physical demand. In contrast, the odds of experiencing a hospitalization for any cause were lowest for Soldiers in the highest physical demands jobs, followed by moderate demands, with Soldiers in the light demands jobs at greatest risk for any-cause hospitalization.

There are several possible reasons for these associations. First, the odds ratios for the year 2000 and the average annual rates evaluated for the 1980-2006 study period are not adjusted by gender or age. Since we know that women comprise a larger percentage of light occupations, these increased overall hospitalization rates may reflect greater risk for hospitalizations for a variety of gender-specific causes such as childbirth.

It is also possible that these observed rates and odds ratios reflect a "healthy worker effect" or selection bias in that those with more overall health conditions either do not choose to enter or are not placed in heavier physically demanding jobs. Rather, those more likely to experience a hospitalization of any nature could be serving in lighter physically demanding categories.

A third possible explanation is that while heavy demands jobs place a Soldier at greater risk for acute injury, they also are protective against other types of problems and possible musculoskeletal disorders. In contrast, light demands jobs may be more sedentary and thus increase risk for certain chronic musculoskeletal problems (e.g., back pain) and/or problems other than acute injury.

The finding that Soldiers in heavy demands jobs were at greater risk for injury-related hospitalizations than were Soldiers in moderate or light demands jobs may, in part, validate the physical demand classification of a particular MOS. It also raises questions about whether the Army should employ a more appropriate method to evaluate and ensure proper matching of Soldiers to occupations so that job assignment reflects physical capabilities. Better assessment of physical capabilities and then careful matching to jobs by demands may reduce the risk for on-the-job acute injuries.

On the other hand, it is possible that heavy physically demanding jobs themselves may be so hazardous that even well-trained and fit Soldiers will still be at increased risk for injuries. A greater proportion of the injuries experienced by Soldiers in high-demands jobs occurred while they were on duty, suggesting that their jobs are, in fact, potentially hazardous. In contrast, Soldiers working in light demands jobs were both less likely to be injured and, if they were injured, the injury was less likely to have occurred while on the job or during training. If there is still excess injury, even after better assessment and matching of Soldiers to jobs, then it might be necessary to re-evaluate the ergonomics of the jobs and identify ways to better protect Soldiers in heavily demanding jobs. More research is needed to clarify whether better assessment

and assignment will mitigate excess injury risk experienced by Soldiers in jobs that have heavy physical demands. In addition, an assessment of the long-term effects of occupational exposures via increased risk for disability and other adverse outcomes should also be undertaken.

STRENGTHS AND LIMITATIONS

The classification of military occupational specialties by levels of physical demand, particularly the construction of a crosswalk to examine occupations across a 27-year period, is a significant strength of this report. While individual MOS codes can be identified by physical demand in AR 611-21, the ability to group multiple common occupations by physical demand level allows for a more in-depth look at physical demand categories as a whole. Moreover, by following occupations over time and documenting coding changes, we were able to learn much more about the evolution of specific military occupations than basic frequencies from 1980-2006 would have allowed. Instead, we were able to track temporal trends in hospitalization rates among Soldiers within the same occupations of interest over time. If instead we had used only a specific MOS code at one given point in time for a given occupation, this opportunity would have been lost. This crosswalk allows for larger occupational cohorts and to examine the link between exposures to light, moderate and heavy demand jobs and adverse health outcomes.

Another key strength of this study was the linkage of physical job demands with objective health outcomes data. This linkage allows us to assess the relative utility of the job demands scale for identifying demanding jobs and also points to the need to continue working to reduce injury risk in these high demands jobs. Because on-the-job injuries are still a problem within high demand jobs, it is clear from these data that more needs to be done to match Soldiers to the demands of these jobs and more needs to be done to protect Soldiers engaged in these highly demanding jobs. More research documenting the nature and type of injury among highly demanding jobs, as well as long-term consequences, such as disability, would be useful for focusing ergonomic assessments and job redesign efforts.

A limitation of the crosswalk process is that while we are confident that we captured many coding changes and restructuring of specific occupations, we cannot be certain that all changes were accounted for. There are no central records documenting historical changes in MOS coding conventions, so we have no way of confirming that we did, in fact, account for all coding transitions. Additionally, when a certain code was changed, dropped or added, we cannot guarantee that coders began applying these new codes at the time they were implemented. We found strong evidence suggesting that, in fact, there often was a delay in implementing MOS code changes, especially when some occupational codes were discontinued and later replaced by alternative codes. Rather than seeing the original code drop off and the new code immediately populated, there were sometimes considerable counts of Soldiers holding the original “discontinued” code, even after it was supposedly dropped.

While our large occupational cohorts allowed us to identify trends in hospitalizations, the results from this preliminary analysis are unadjusted. Thus, we cannot disentangle the influences of certain body composition or exposure factors, such as gender, age or other demographic factors and injury outcomes. Future work should include adjustments for gender, age and other key demographic factors associated with both job demands, other risk exposures and occupational injury.

We focused on primary ICD-9-CM clinical diagnoses to determine if a hospitalization was injury- or musculoskeletal-related. Thus, it is possible that we are missing important linkages or patterns between injuries or musculoskeletal conditions and physical demand categories. We may miss, for example, common comorbid musculoskeletal conditions that resulted from an occupational injury. We did not evaluate disability rates for individuals within certain physically demanding occupations. However, evaluating long-term effects of occupational physical demands is warranted and should be included in future research efforts.

Despite these limitations, this study was still able to provide a detailed picture of the association between the physical demands of military occupations and risk for serious adverse health events (hospitalization). Our ability to link biannual personnel records with hospitalization data at the individual level is a unique strength of this study. Using the TAIHOD database, we were able to study a relatively large sample of Soldiers over a 27 year period, as well as learn about MOS coding patterns throughout that time.

CONCLUSIONS AND RECOMMENDATIONS

- Injury hospitalization rates, as well as data on whether injuries are job-related, suggest that military occupations are generally accurately classified as light, moderate and heavy physical demands.

- The higher incidence of injury among Soldiers assigned to heavy physically demanding jobs might suggest that the assignment and reclassification processes are in need of revisions or more thorough implementation. Alternatively, it could suggest that the demanding nature of these jobs still results in greater injury risk even among those Soldiers who are most physically fit.

- Lighter physically demanding jobs have higher rates of any-cause hospitalizations, whereas heavier physically demanding occupations have higher rates of injury-specific hospitalizations. This may be due to greater proportions of women in light-demands jobs who are also at greater risk for hospitalizations. It could also reveal a healthy-worker type of bias, where the screening process places those who are more vulnerable to illness in less physically demanding jobs, or less-demanding jobs themselves may result in a less fit workforce at greater risk for many adverse health problems (except acute injury).

- On-duty serious accidents (those resulting in an injury hospitalization) occur more frequently among heavy physically demanding jobs. Soldiers in 11B (Infantrymen), 19D (Cavalry Scout) and 11C (Indirect Fire Infantrymen) were at greatest risk for on-the-job injuries resulting in hospitalization within heavy physically demanding occupations.

- The dynamic nature of MOS nomenclature over time makes the study of any temporal patterns or risk factors for injury or disability within an occupational cohort difficult. The ability to crosswalk MOS codes over time is a great advantage for the study of any long-term health or behavioral trends among specific military occupations of interest.

- Identifying MOS codes according to their assigned level of physical demand can help determine differential risk factors for injury. Such information can be used to develop targeted interventions for specific occupations within the military.

- More research is needed that explores long-term chronic conditions and disability related to occupational physical demand and to clarify the independent influence of job demands once demographic factors are controlled.

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Appendix E

USARIEM Human Use Review Committee

CONTINUING REVIEW REPORT

In accordance with Federal Regulations 45CFR46, the Human Use Review Committee must review protocols at least annually or more frequently to approve human subject involvement. Please complete this form and return to ORQC.

Protocol Number: USARIEM H00-10y Date of this Report _19 Jul 2007_____

Principal Investigator ___Nicole S. Bell_____

INITIAL HURC REVIEW DATE _16 August 2005_____

PREVIOUS CONTINUING REVIEW DATE ___20 July 2006 (date submitted)_____

THIS REPORT COVERS THE PERIOD 21 July 2006- 18 July 2007

Title: Risk factors for discharge from the Army with a permanent disability

PROTOCOL SUMMARY: 100 words

This research focuses on risk factors for permanent disability discharge in active duty Army personnel. The main hypothesis is that disability results from a combination of health, occupational, and personal factors that can be identified prior to the onset of a potentially disabling condition. It is further hypothesized that many of these factors are modifiable. Understanding the factors associated with an increased risk for medical disability discharge or retirement is necessary in order to develop targeted and cost-efficient disability reduction strategies and manage the conditions that may eventually lead to permanent disability and the premature loss of active duty soldiers.

1. Number of VOLUNTEERS REQUESTED in the APPROVED protocol: ___N/A_____
2. DURING THIS REPORTING PERIOD I HAVE ENROLLED __ N/A _____ VOLUNTEERS.

   I PLAN TO ENROLL MORE VOLUNTEERS N/A
3. Please complete the following table:

	Number of volunteers Male/Female
VOLUNTEERS INITIATED into the study FOR THIS REPORTING PERIOD	N/A
VOLUNTEERS WITHDRAWN or withdrew THIS REPORTING PERIOD*	N/A
VOLUNTEERS COMPLETING TESTING TOTAL TO DATE	N/A

*Reasons for withdrawals_____

4. List and briefly describe all ADVERSE EVENTS FOR THIS REPORTING PERIOD:
   Date Adverse Event Description

5. New developments or publications influencing volunteer participation or risk
Summarize the new development(s) and/or reference literature source and title.

N/A

6. List AMENDMENTS made to the research FOR THIS REPORTING PERIOD:

Date	Amendment Number	Description
Approved by Commander 4 Feb 2007	1	Added consultants to protocol
Approved by Commander 18 July 2007	2	Consultants removed, consultant added, PI changed, SOW schedule revised

7. List DEVIATIONS occurred during research FOR THIS REPORTING PERIOD:

Date	Description

8. Are the research files and laboratory notebook being maintained in accordance with USARIEM-Memo 70-25 and 70-55: N/A

9. Are the files and laboratory notebook ready for periodic review? N/A
Where is data stored, if laboratory notebook is not use?

10. Use a separate SHEET TO SUMMARIZE FINDINGS reported to date
An annual report summarizing all work over the previous year is being submitted 27 July 2007 to the granting agency. A copy will be provided to USARIEM as soon as it is available.

11. List PUBLICATIONS, PRESENTATIONS, and ABSTRACTS resulting from this study.
Please provide complete citations. If there have been none, please indicate.

None

ATTACHMENTS:
PRIVILEGE REVIEW SHEET

Principal Investigator/ Date

Division Chief / Date 7/23/07

HURC Reviewer / Date 7/24/07

Allen Cymerman, Ph.D. / Date 7/24/07
HURC Chair Vice Chair

POR BEAU J. FREUND, COL, MS 21 JULY 2007
USARIEM Commander Date